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Lygus bugs on the prairies

Biology, systematics, and distribution

Canada

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Biology, systematics, and distribution

Presents keys to the adults and nymphs of the pest species of *Lygus* encountered in the Prairie Provinces, accompanied by diagnoses and illustrations detailing the variation of each species, and a review of the pertinent literature.

MICHAEL D. SCHWARTZ and ROBERT G. FOOTTIT
Biological Resources Division
Centre for Land and Biological Resources Research
Ottawa, Ontario

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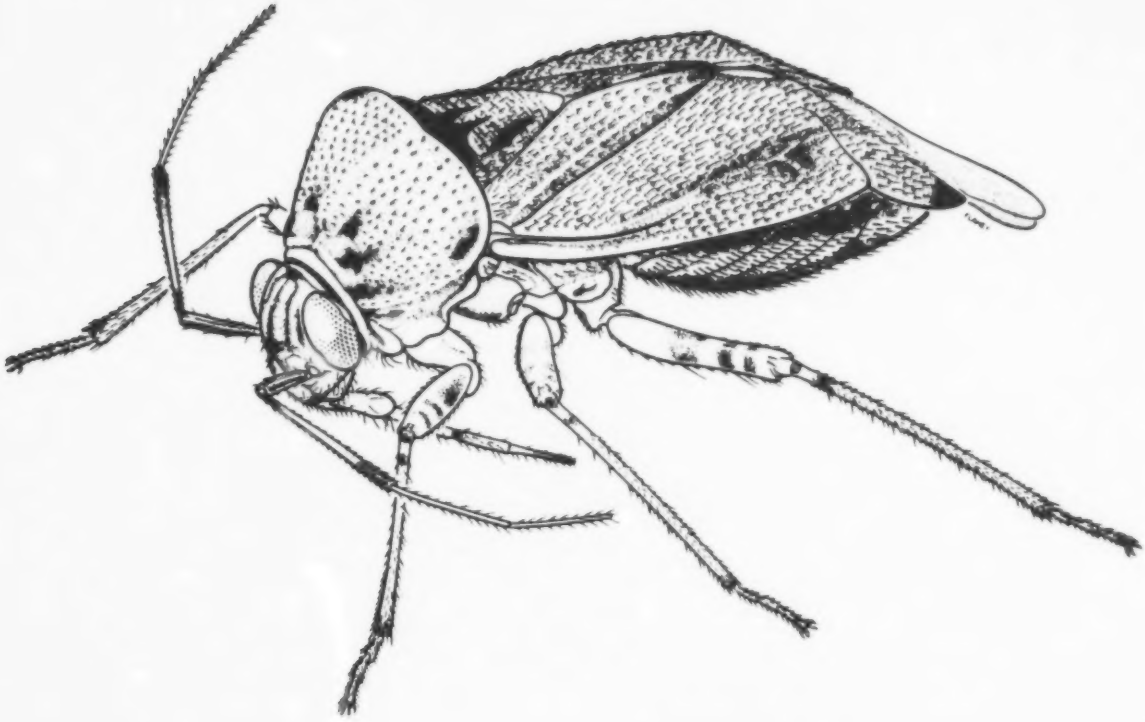
Frontispiece
Lygus lineolaris (Palisot), habitus of female, Ottawa, ON.



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PREFACE

The great species diversity, wide range of feeding habits, and damage inflicted on fruit, food, field crops, and ornamental plants, make lygus bugs one of the most significant insect groups to the Canadian agri-food sector. In the Prairie Provinces lygus bugs are serious pests of seed alfalfa and oilseed rape. Keys to the adults and especially nymphs of *Lygus* are of critical importance if pest species are to be recognized rapidly so control efforts can be initiated before insect numbers reach economic thresholds. *Lygus* species concepts, a prerequisite to accurate identification keys, are inadequately delimited because seasonal color forms, sexual dimorphism, geographical variability, and host plant races have resulted in great inter- and intraspecies morphological variation. The keys, diagnoses, descriptions, and illustrations of the adult and instar stages presented here incorporate the sexual and seasonal variation of lygus bugs encountered in the Prairies. Our study is based on a review of all the pertinent literature, and the results of field surveys conducted by the authors and collaborators at research station in the Prairies.

SUMMARY

The keys, diagnoses, descriptions, and illustrations of the adult and instar stages provided are intended to apply to lygus bugs found in the cultivated region extending from southeast Manitoba northwest and west to Duck Mountain and southwest Manitoba across Saskatchewan south of Prince Albert to Alberta east of the Rocky Mountains. The descriptive text and illustrations incorporate the variation encountered within each sex and seasonal form of the adults in following species: *Lygus borealis* (Kelton), *L. elisus* Van Duzee, *L. lineolaris* (Palisot de Beauvois), *L. rubrosignatus* Knight, *L. shulli* Knight, and *L. solidaginis* (Kelton). In agricultural situations, the first three species are most often collected whereas the last three species usually occur in much lower numbers. *Lygus borealis* and *L. elisus* are readily recognized by the small size (under 6mm) and the light green color of the ventral side of the body. *Lygus lineolaris* is distinguished from the previous two species by the darker body color, the diagnostic submedian stripe, and the red or red brown lateral margin of the mesoscutum. The key to the instar stages is based on differential thoracic and antennal segment development, as well as the dorsal markings. All the instar stages of *L. lineolaris* are distinguished from *L. borealis* and *L. elisus* by the relative length of antennal segment 4. A diagnosis and description of *L. hesperus* instars are included to provide for the identification of the immature stages of this important western North American plant bug pest in regions of Canada where it is sympatric with *L. borealis*, *L. elisus*, and *L. lineolaris*.

RÉSUMÉ

Les tableaux de détermination, diagnoses, descriptions et illustrations de la forme adulte et des stades nymphaux présentées décrivent les punaises du genre *Lygus* vivant dans la région de culture qui s'étend du sud-est du Manitoba, vers le nord-ouest et l'ouest jusqu'au mont Duck, ainsi que du sud-ouest du Manitoba jusqu'en Alberta à l'est des montagnes Rocheuses en passant par la partie sud de la Saskatchewan jusqu'à la hauteur de Prince Albert. Le texte ainsi que les illustrations qui l'accompagnent décrivent la variation observée chez chacun des deux sexes et chez les formes saisonnières des adultes des espèces suivantes: *Lygus borealis* (Kelton), *L. elisus* Van Duzee, *L. lineolaris* (Palisot de Beauvois), *L. rubrosignatus* Knight, *L. shulli* Knight et *L. solidaginis* (Kelton). Dans les régions agricoles, on recontre surtout les trois premières espèces; les trois autres sont habituellement beaucoup moins nombreuses. *Lygus borealis* et *L. elisus* sont facilement reconnaissables à leur petite taille (moins de 6 mm) et à la couleur vert pâle de la face ventrale de leur corps. *Lygus lineolaris* se distingue des deux espèces précédentes par la couleur plus foncée de son corps, par la rayure submédiane caractéristique et par la couleur rouge ou brun-rouge du bord latéral du mésoscutum. Le tableau de détermination des stades nymphaux est basée sur le developpement différentiel du thorax et des articles antennaires ainsi que sur les taches dorsales. Tous les stades nymphaux de *L. lineolaris* se distinguent de ceux de *L. borealis* et de *L. elisus* par la longueur relative du 4^{e} article antennaire. On y présente en plus une diagnose et une description des nymphes de *L. hesperus* afin de faciliter l'identification des stades immatures de cet important ravageur phytophage de l'ouest de l'Amérique du Nord, là où il vit en sympatrie avec *L. borealis*, *L. elisus* et *L. lineolaris* au Canada.

INTRODUCTION

This technical bulletin introduces the economic entomologist or grower to the information available on the biology, systematics and distribution of the agriculturally important lygus bugs in the Prairie Provinces of Canada. The intended geographical coverage is the cultivated regions from southeast Manitoba northwest and west to Duck Mountain and southwest Manitoba across Saskatchewan south of Prince Albert to Alberta east of the Rocky Mountains. Field and laboratory keys of adult and instar stages of *Lygus* species found within this geographical area are accompanied by diagnoses and illustrations detailing the variation encountered in each species. Other species of *Lygus*, as well as species of other genera, are collected on the Prairies, but they can be discriminated from the species treated herein by consulting the included diagnosis of the genus and the identification keys of Kelton (1975, 1980), Knight (1923, 1941a, 1968), and Slater and Baranowski (1978).

The field keys were designed to be workable with a 10X hand lens. The identification of *Lygus* species is facilitated by the accurate assessment of the range of variation (mostly color) encountered in a population. This can be accomplished only by the collection of long series of specimens; fortunately in the prairie agricultural situation the accumulation of sufficient *Lygus* study material is not difficult. Most of the specimens examined for this study are housed at the Canadian National Collection, Ottawa, Ontario. Additional material was acquired from several Agriculture Canada Research Station and university collections (see Acknowledgments). Collection techniques for mirids are discussed in Kelton (1980). Structural terminology (Fig. 1) follows that of Knight (1917, cf. plate 23; 1923, cf., Fig. 47) and Kelton (1980, cf., Fig. 1). Four terms used throughout the keys and species treatments not included on Figure 1 are "dorsum," "infuscation," "venter," and "vestiture." These terms are defined in Systematics. Immature stages for this study were preserved in both 70% ethyl alcohol or "Weaver and Thomas solution;" a fixative that includes formaldehyde, glacial acetic acid, and chloral hydrate (Weaver and Thomas 1956). All measurements are in mm. Table 1 reports the range, mean ($\bar{X}$), standard error (±SE), and sample size (N) of eight measurements for each instar of *L. borealis* (Kelton), *L. elisus* Van Duzee, *L. hesperus* Knight, *L. lineolaris* (Palisot de Beauvois), and *L. shulli* Knight (instars 3-5 only).

Host plant records cited in the species treatments are compiled from the applied literature of Canada and the northern United States, as well as the specimens examined. Reference was made to these sources only if information was available on the immature stage of a specific *Lygus* species. The most extensive listings of host plant species for *Lygus* are those of Scott (1977) for *L. hesperus* and Snodgrass et al. (1984a, 1984b) and Young (1986) for *L. lineolaris*. We have also summarized pertinent host plant findings from the same literature. All botanical names adhere to Budd's Flora of the Prairie Provinces (Looman and Best 1987). The literature on lygus bugs is very large but accessible on a worldwide basis from 1900-1980 (Graham et al. 1984b, Scott 1981). A useful summation of the economic importance and biological control research of lygus bugs and *Adelphocoris* Reuter was presented in Hedlund and Graham (1987).

LITERATURE REVIEW

Biology

Regionally the most important *Lygus* pests are the "tarnished plant bug," *L. lineolaris*, which is distributed continent wide and is the only species causing economic damage in eastern North America on seed alfalfa, cotton, mustard, vegetables, and fruit crops and *Lygus hesperus*, the "western tarnished plant bug," which occupies approximately the same ecological niche as *L. lineolaris* in the East, but is more prevalent than it on alfalfa and cotton in western North America (Day 1987). The "pale legume bug," *L. elisus*, also distributed in western North America, is not as numerous on southwestern alfalfa as *L. hesperus*, but is a serious pest of oilseed rape in the Prairie Provinces (Butts and Lamb 1991b). *Lygus borealis* is the most numerous *Lygus* species occurring on alfalfa in parts of the Prairie Provinces (Butts and Lamb 1991a, Schwartz and Foottit 1992). The "European tarnished plant bug," *Lygus rugulipennis* Poppius, indigenous to the Palearctic, causes the same type of damage and affects many of the same crops as North American *Lygus* species (Day 1987).

Because of the tremendous host plant breadth of *Lygus* species, Scott (1987) predicted two implications

for agriculture. First, most cultivated vegetables, fruits, forage, and seed crops can be damaged by *Lygus* species if circumstances are correct. Second, although three species are now considered economic pests, other species can potentially inflict the same type of damage to current or new crops under different conditions or in different regions. This situation occurred in the Prairie Provinces where a burgeoning rapeseed oil industry has planted large acreages of canola (Lamb 1989) and a new *Lygus* species, *L. borealis*, has risen to pest status on both canola and seed alfalfa (Butts and Lamb 1991b).

Hosts

Studies on the weed host plants of *Lygus* species have been completed for several regions: southern Arizona and southeastern California (Stitt 1949), northern Texas (Anderson and Schuster 1983, Womack and Schuster 1987), Mississippi (Cleveland 1982, Snodgrass et al. 1984b), southern Québec (Stewart and Khoury 1976), and southern Finland (Varis 1972). There are no intensive studies that have determined the sequence of weed hosts of *Lygus* in the Prairie Provinces. The host plant sequence of *Lygus* species in eastern and central Washington (Fye 1980, 1982a) and the Lewiston-Moscow area of Idaho (Domek and Scott 1985) may be indicative of the Prairie situation. Fye (1980, 1982a) and Domek and Scott (1985) have documented that the continuity of hosts, in the reproductive stage throughout the season, can be more important to *Lygus* abundance than plant species diversity per se, although continuity implies a certain amount of diversity (Domek and Scott 1985). In eastern Washington, Fye (1980, 1982a) reported that weeds formed a perfectly sequenced host series for lygus bugs throughout the season. The early crucifers, hoary cress (*Cardaria draba* (L.) Desv.), flixweed (*Descurainia sophia* L.), tumble mustard (*Sisymbrium altissimum* L.), and shepherd's-purse (*Capsella bursa-pastoris* (L.) Medic.), are available from late March to June. These species are followed in June to mid-July by perennial pepperweed (*Lepidium latifolium* L.) and volunteer alfalfa (*Medicago savita* L.). The chenopods, lamb's-quarters (*Chenopodium album* L.), kochia (*Kochia scoparia* (L.) Schrader), Russian thistle (*Salsola australis* Brown), and pigweed (*Amaranthus retroflexus* L.), follow in mid-July and extend into the fall. From August to the onset of freezing temperatures the composites, ragweed (*Ambrosia artemisiifolia* L.), horseweed (*Conyza canadensis* (L.) Scop.), and false ragweed (*Iva xanthifolia* Nutt.), join the late developing chenopods to act as hosts for *Lygus* destined to overwinter. Additionally, plants which flower continuously such as alfalfa and wild carrot (*Daucus carota* L.) serve as a substitute for host sequencing (Scott 1987).

We do know that lygus bugs of economic importance in the Prairie Provinces use a great variety of host plants for feeding and oviposition purposes. The life history of these species was summarized by Kelton (1955c) as follows: in northern agricultural areas the species generally emerge from diapause in April and early May, and feed on the reproductive structures of such early-growing plants as, *Arctostaphylos* sp., *Ledum* sp., *Salix* spp., and alfalfa when it becomes suitable for feeding and oviposition. Further south the species feed on *Salix* spp., *Symphoricarpos* spp., and caragana, then disperse in May and June, to herbaceous plants such as volunteer alfalfa, as well as cultivated crops, and in June and July, to *Aster* spp., *Solidago* spp., and *Artemisia* spp. for oviposition; these later plants are apparently more suitable for oviposition when alfalfa is nearly mature.

Agronomic activities that result in plant and soil community disruption have done much to favor the establishment and growth of herbaceous plant communities, which support many of the species of economically important *Lygus*. Habitat instability is encouraged by discing weeds along ditch banks, roadsides and wasteland corners of irrigation pivots. Another reservoir of *Lygus* populations is volunteer alfalfa propagated on roadsides along the edges of previously cultivated fields and kept in prime condition by overshooting irrigation water. If the population density of a species of *Lygus* increases on an uncultivated host before crops are available, control of these hosts may indirectly prevent the population buildup of *Lygus* on the crop (Fye 1980, Domek and Scott 1985).

Although weeds support *Lygus* populations, especially in the spring, such host plants are also primary attractants for parasites and predators (Scott 1987). Rates of parasitism for some parasitoids are often higher on *Lygus* associated with native host plants (e.g., *Erigeron* spp.) which have attractive floral odors (Shahjahan 1974). Henry and Lattin (1987) concluded in a report on the economic importance and biological control of *Lygus* species that more information on the life history including hosts, phenology and population dynamics of *Lygus* species

is necessary to develop efficient and effective control strategies.

Number of generations

Many *Lygus* species are multivoltine. However, within a species the number of generations per year probably varies directly with accumulated degree-days above 10°C (Champlain and Butler 1967). In western Canada the agriculturally important *Lygus* species are univoltine north of 53°30′ N latitude with no summer adults becoming reproductive in the same year (Craig and Loan 1987). In these parkland regions, e.g., Vegreville and Fairview, Alberta (Butts and Lamb 1991a) and Torch River, Saskatchewan (Craig 1983, Soroka 1991), the immatures emerge in late May through July and adult populations peak in late August and September. The nymphs are found until late in the fall, gradually decreasing in number throughout September on crops and weeds hosts. South of approximately 50° N latitude the same *Lygus* species are bivoltine; overwintered adults are present from the end of April to about mid-June, or sometimes July. The first generation immatures emerge in mid-May to mid-June with adult populations reaching peak numbers in mid-July. Second generation immatures emerge in late July to early August with adults peaking in early September (Craig 1983, Schaber 1992, Soroka 1991). Bivoltine populations are found in Lethbridge, Alberta (Salt 1945), Winnipeg, Manitoba (Gerber pers. comm.), and Moose Jaw and Saskatoon, Saskatchewan (Craig 1983). In the southern United States *L. hesperus* and *L. lineolaris* may produce as many four or five overlapping generations a year (Day 1987, Strong et al. 1970). In the following species treatments the non-overwintered bugs of either univoltine and bivoltine populations are referred to as the summer generation(s).

Overwintering

Craig (1983) concluded that *Lygus* adults generally do not overwinter in alfalfa fields. In the fall as alfalfa matures, bugs move to more succulent native autumn plants, then hibernate in the shelter of plant litter. Fye (1982b) determined that deciduous orchard duff and mullein, *Verbascum thapsus* L. (an introduced biennial with succulent foliage in the late fall), were principal overwintering sites of adult *Lygus* in central Washington. Mullein is also one of the few host plants, when not in reproductive condition, to be used by *Lygus* species (Scott 1987). Possible overwintering sites in the Prairie Provinces are hedgerow, windbreak, and surrounding parkland litters.

Damage

All species of *Lygus* feed preferentially on either the developing reproductive organs (buds, flowers, and developing seed) or on the apical meristematic and leaf primordia tissue (Strong 1970). Feeding by *Lygus* causes several types of damage: "blasting," the abscission of the fruiting body, and the production of shriveled seed or seed without embryos; "catfacing" of peaches and "apical seediness" of strawberries, the deformation of young fruits; necrosis surrounding the feeding area; and reduction of vegetative growth (Strong 1970). It is the concentration of feeding on reproductive parts that make *Lygus* among the most insidious pests of seed crops. Without an uninfested comparison such feeding can go unnoticed, explaining why *Lygus* damage was recognized on fruits before seed crops (Crosby and Leonard 1914, Lamb 1989, Scott 1987).

Variation in color

All species of *Lygus* exhibit a pattern of seasonal coloration darkening with the resulting polychromatism between the overwintered or spring generation and the summer generation causing considerable confusion for species recognition (Kelton 1975). Herein we describe in detail the seasonal color variation of agriculturally significant lygus bugs in the Prairies. Color darkening of *L. elisus* (as *L. desertinus*), *L. hesperus*, and *L. lineolaris* did not increase with photoperiod but was a function of physiological age, which can be accelerated by higher temperatures (Wilborn and Ellington 1984). Because of the phenomenon of cuticular darkening it is possible to determine the age of field-collected *L. lineolaris*, in Celsius degree-days, by the laboratory technique of assessing the percentage light transmittance through prepared adult specimens (Stewart and Gaylor 1991). Light transmittance may be affected by host plant species (Stewart and Gaylor 1990).

Systematic history

The systematics of North American *Lygus* has not been tied only to our knowledge of the prairie species, but also to the researchers credited for assembling the specimens and current knowledge were from the Prairies. Leonard A. Kelton (from the former

Biosystematics Research Institute) published all of the major works examining the prairie elements of the genus. He and Arthur R. Brooks (Saskatoon Research Station) collected almost all of the material used in Kelton's prairie *Lygus* papers. Kelton (1955a, 1973a, 1974) delimited *Lygus* sensu stricto for North America by placing former *Lygus* species in the genera *Agnocoris* Reuter, *Knightomiris* Kelton, *Orthops* Fieber, *Pinalitus* Kelton, and *Salignus* Kelton. He described six new species of *Lygus* (Kelton 1955b, 1973b) distributed in the Prairies and western North America, and presented the first (1955c) and latest (1980) systematic works for the lygus bugs of the Prairie Provinces. His revision of *Lygus* (1975) and the collection upon which it was based (housed in the Canadian National Collection, BRD/CLBRR) provided the starting point for our study. Without this research and collection legacy the information presented herein would not have been possible.

Economic entomology

Alfalfa (*Medicago sativa*) grown for seed and oilseed rape or canola (*Brassica campestris* L., *B. napus* L.) are the crops most seriously impacted by the feeding of lygus bugs in the Prairie Provinces.

Oilseed rape

Butts and Lamb have explored the interactions between three pest species of *Lygus* and oilseed *Brassica* in Alberta, investigating several aspects of *Lygus* biology: seasonal abundance (1991a), pest status (1991b), mode of injury to *Brassica* (1990b), and suitability of several oilseed *Brassica* cultivars (1990a). Their conclusions are very briefly summarized as follows: *Lygus borealis*, *L. elisus*, and *L. lineolaris* annually invade, reproduce in, and develop in Alberta oilseed *Brassica*. The most injurious stages of lygus bugs, the fourth and fifth instars and the adults, are synchronized with the susceptible reproductive phase of the crop (Butts and Lamb 1991a). *Lygus* injury to oilseed *Brassica* is like that described for other crops and consists of visible lesions to surfaces of stems, buds, flowers, and pods. The feeding injury causesbuds and flowers to abscise, seeds to collapse within the pods, and the weight of healthy seeds per pod to be reduced (Butts and Lamb 1990b). Oilseed *Brassica* is most susceptible to *Lygus* injury during the pod stage (Butts and Lamb 1991a). Even though oilseed *Brassica* can compensate for bud and flower loss so that there is no net reduction in the number of pods, seed yield will decline as a result of *Lygus* injury because the plant can not compensate for collapsed seed (Butts and Lamb 1990b). As *Lygus* density increases, the percentage of seed injured increases and seed yield decreases (Butts and Lamb 1991b). Oilseed rape with high or low levels of glucosinolates were as suitable as hosts for *Lygus* species as alfalfa (Butts and Lamb 1990a). In Alberta, oilseed *Brassica* plants in a drought stressed condition received the most injury from *Lygus* (Butts and Lamb 1991b).

Leferink and Gerber (1989) and Timlick et al. (1989) have studied the pest status of *Lygus* species on oilseed *Brassica* in Manitoba, and Gerber (in prep.) is compiling life history information for *Lygus* species in southern Manitoba. The survey of *Lygus* species by Schwartz and Foottit (1992) presented data to show that the three agriculturally important *Lygus* species on oilseed *Brassica* are not uniformly distributed across the Prairies, and that three other *Lygus* species (*L. rubrosignatus* Knight, *L. shulli*, and *L. solidaginis* (Kelton)), occur in low numbers on the crop in Alberta and Saskatchewan.

Alfalfa

Lygus populations and their relationship to the occurrence of damaged alfalfa seed was first studied by Sorenson (1936). Feeding by immature and adult stages of lygus bugs injures buds, but greatly reduced seed yield is usually a consequence of damage to flowers and young seed, which causes blasting and shrunken, nonviable seed (Soroka 1991, Schaber 1992). Lygus bug research on seed alfalfa in the Prairie Provinces has provided information on seasonal abundance (Salt 1945, Craig 1983, Butts and Lamb 1991a), control by burning (Bolton and Peck 1946, Schaber and Entz 1988) , cutting (Harper et al. 1990) or chemicals (Craig 1961), and host plant suitability (Butts and Lamb 1990a).

Various aspects of lygus bug/alfalfa entomology have been studied elsewhere in North America. Some of these findings may have application to systems in the Prairies: (1) symptoms and physiological effects of feeding (Carlson 1940, Jeppson and MacLeod 1946), (2) forage quality and yield in first-crop alfalfa in South Dakota (Walstrom 1983), (3) forage yield reduction in second-crop alfalfa in Idaho (Shull et al. 1934), (4) seedling damage in Idaho (Fye 1982c, 1984), (5) sampling techniques (Graham et al. 1984a), (6) economic threshold in Ontario (Smith and Ellis

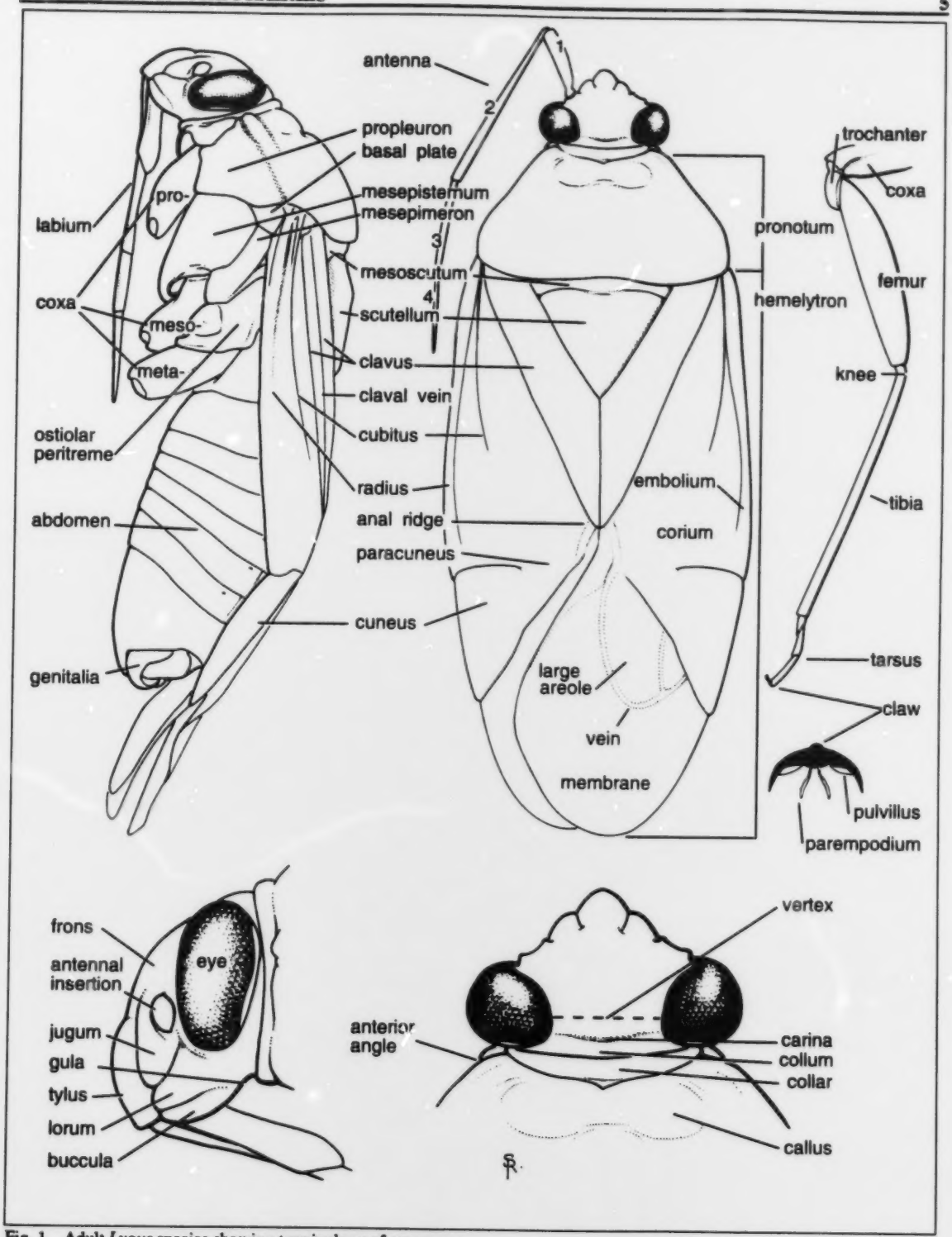


Fig. 1 Adult *Lygus* species showing terminology of structures.

1983), (7) chemical control (Burkhardt et al. 1986, Isenhour 1985), (8) host plant resistance (Lindquist et al. 1967), (9) strip cutting of alfalfa as a control measure in cotton (Stern et al. 1964, Butler et al. 1971), (10) the interaction of lygus bugs on alfalfa and cotton (Cave and Gutierrez 1983), (11) the interaction of lygus bugs on alfalfa and beans (Stoltz and McNeal 1982), (12) [illegible]ionship to seed production in Arizona and California (Stitt 1940), and (13) seasonal phenology of lygus bugs in Minnesota (Radcliffe et al. 1976).

SYSTEMATICS

Terms

Dorsum – the general upper surface of the bug. **Infuscation** – the smoky, mottled appearance of the dark colored portions of the body. **Venter** - the general lower surface of the bug. **Vestiture** – the general surface covering of the body, composed of setae (hairlike cuticular projections).

Diagnosis of *Lygus* adults

Lygus bugs are placed in the subfamily Mirinae, tribe Mirini, and have the following diagnostic characters of these higher groups: (1) large, divergent, membranous parempodia, (2) pronotum with a collar that is wider than the width of antennal segment 2, (3) basal segment of metatarsus shorter than the combined length of segments 1 and 2, (4) body form not myrmecomorphic (ant-like), and (5) with a well-developed ostiolar peritreme. *Lygus* is further distinguished from other genera of the Mirini by the following combination of characters: (1) Pronotum shining, with unobscured, deep and widely separated punctures (punctures are absent between collar and calli; calli are either setose or glaborous), (2) lateral margin of pronotum rounded, (3) antennal segment 1 and 2 linear, with simple setae; segment 2 longer than width of head, (4) scutellum deeply punctate and not swollen, (5) dorsal surface with subappressed simple setae, (6) lateral margin of pronotum usually convex, (7) cuneus deflexed, (8) vertex without a medial sulcus and usually with a carina between eyes, (9) frons without medial groove (frons sometimes obliquely striate or grooved), (10) head oblique, (11) eye elliptical, with ventral margin extending below antennal insertion in lateral view, (12) claws rounded not sharply angled, (13) pronotum without velvety, depressed black spots posterior to calli, but usually with shining, black spots or rays posterior to calli, and (14) overall coloration never completely black or with bold, parallel, black stripes on dorsum.

Key to the species of adult *Lygus*

1. Frons with submedian stripe (Fig. 2), sometimes stripe broken, or present as a single spot only; lateral margin of mesoscutum yellow or red, in contrast to dark medial section; scutellum with median and lateral stripes; cuneus pale, apical one-fifth dark; anterior angles of pronotum slightly, but usually, abruptly protruding, in lateral view; propleuron with short, median ridge ..... *L. lineolaris* (Palisot de Beauvois)

— Frons without submedian stripe; mesoscutum unicolored (sometimes *L. elisus* with lateral margin pale); scutellum and cuneus variously marked; anterior angles of pronotum rounded or slightly protruding, in lateral view; propleuron sometimes with short, median ridge 2

2. Lateral margin of mesoscutum pale, in contrast to dark medial section; anterior angles of pronotum rounded, in lateral view; apex of cuneus dark ..... *L. elisus* Van Duzee

— Mesoscutum unicolorous; anterior angles of pronotum rounded or slightly produced, in lateral view; apex of cuneus either pale or dark 3

3. Anterior angles of pronotum rounded, in lateral view (Fig. 3); propleuron without dark marking just ventral to anterior angles of pronotum; apex of cuneus dark ..... *L. elisus* Van Duzee

— Anterior angles of pronotum produced, in lateral view (Fig. 4); propleuron with dark marking just ventral to anterior angles of pronotum; apex of cuneus variously marked 4

4. Body conformation compact; general coloration, including ventral aspect, mostly green; apex of cuneus unicolorous, sometimes apex slightly darkened; pronotum flattened with sparse, shallow punctures, anterior angles not prominent in dorsal view; hemelytra mostly

translucent; scutellum flattened in lateral view; vestiture short and sparse; antennal segment 2 length 1.25-1.70; apex of labium reaching metacoxa ..... *L. borealis* (Kelton)

— Body conformation elongate or robust; general coloration, including ventral aspect, mostly darkened; apex of cuneus dark; pronotum more convex with dense, deep punctures, anterior angles either prominent or rounded in dorsal view; hemelytra opaque; scutellum more rounded in lateral view; vestiture either short and sparse or long and dense; antennal segment 2 length usually greater than 1.70 (length of antennal segment 2 in *rubrosignatus* as short as in *borealis*, but vestiture of the former is more dense and longer); apex of labium reaching beyond metacoxa to base of abdomen 5

5. Corium with triangular pattern; scutellum with median and lateral lines; margin of cuneus adoining membrane and veins of membrane red; pronotum with dense, deep punctures .... *L. solidaginis* (Kelton)

— Corium without triangular pattern; scutellum with median lines; margin of cuneus adjoining membrane brown or faintly red; veins of membrane brown or pale; punctures of pronotum less dense and deep 6

6. Length of antennal segment 2 from 1.26 to 1.54; vestiture with densely distributed, long, golden setae; conformation of pronotum flattened, anterior angles prominent in dorsal view .... *L. rubrosignatus* Knight

— Length of antennal segment 2 from 1.73 to 1.96; vestiture with sparsely distributed, short, pale setae; conformation of pronotum rounded, anterior angles rounded, in dorsal view .... *L. shulli* Knight

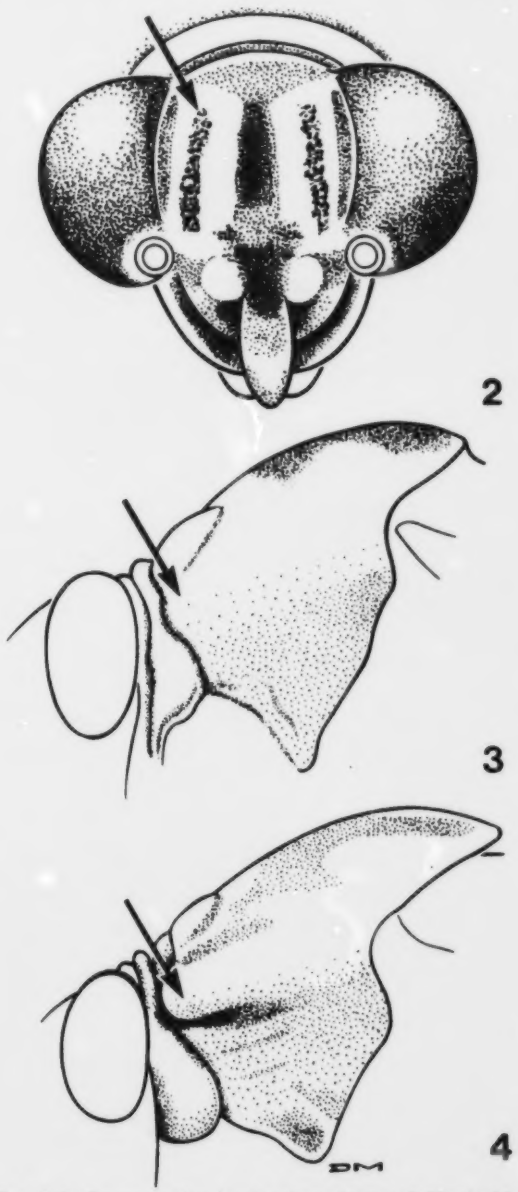
Field key to the species of adult *Lygus*

1. General coloration, especially ventral aspect, pale green; body length usually less than 6 2

— General coloration, including ventral aspect, tan, brown, black or red; body length sometimes greater than 6 3

2. Mesoscutum black; propleuron with black mark; and apex of cuneus usually concolorous with body of cuneus and hemelytra .... *L. borealis* (Kelton)

— Lateral margins of mesoscutum pale; or if entire mesoscutum black, then propleuron without



Figs. 2-4 *Lygus* species, head and propleuron. 2. Head of *L. lineolaris* (Palisot de Beauvois), frontal view, nr. Prawda, MB. 3, 4. Propleuron, lateral view. 3. *L. elisus* Van Duzee, Saskatoon, SK. 4. *L. borealis* (Kelton), Kenosee Lake, SK.

black mark and apex of cuneus black .... *L. elisus* Van Duzee

3. Frons with submedian stripe; summer adults mostly dark brown or black with apex of pale yellow cuneus black; scutellum with median and lateral lines; lateral margins of mesoscutum red or yellow .... *L. lineolaris* (Palisot de Beauvois)

— Frons without submedian stripe; dorsum usually with red cast; scutellum usually with median stripe only; if lateral and median lines present, than corium with brown red or black triangular patch; mesoscutum black 4

4. Corium with brown red or black triangular patch; scutellum with median and lateral lines, lateral line may be present as only a faint red mark; pronotum with dense deep punctures .... *L. solidaginis* (Kelton)

— Corium without dark triangular mark 5

5. Vestiture long and dense with golden sheen; general conformation slightly flattened .... *L. rubrosignatus* Knight

— Vestiture short and sparse without sheen; general conformation rounded ..... *L. shulli* Knight

Discussion of nymphal stages

The immature stages have been described for *L. lineolaris* (Crosby and Leonard 1914) and for *L. elisus* and *L. hesperus* (Shull 1933b). The body regions of *Lygus* instars are mostly weakly sclerotized; as a result, individuals of the same age may show size and shape variation in response to the volume of food consumed, length of time between feeding episodes, as well as the method of preservation. Distortion is noticeable in the abdomen of all instars, but especially when newly emerged and older individuals of instar 1 are compared. Emerged specimens have the head disproportionally large in relation to the shriveled thorax and abdomen, whereas older specimens have body proportions more similar to instar 2. The instar illustrations (Figs. 10-14, 21-25, 32-38, 46-50) of the four agricultural important species document a range of the observed structural distortion. The differences among the illustrations are not species specific; specimens from each species could be selected from preserved material to fit a particular illustration. Those differences, which are actually diagnostic for a species, are incorporated in the following species treatments. Body length and width measurements were recorded from only those specimens which are neither obviously distended or shrunken. Table 1 provides the following measurements: total body length (from apex of tylus to apex of abdomen), width of head across eyes, length of each antennal segment, length of labium (from apex of buccula to tip of segment 4), and length of the metatibia (from insertion to apex).

Color is also influenced by the preservation medium; ethyl alcohol tends to maintain red while Weaver and Thomas solution (1956) alters red to brown or black and accentuates green. When it was not possible to report the color accurately, we simply note that the spots or patterns, contrasting with the general coloration are darkened. Lygus bug instars 3, 4, and 5 are readily distinguished from other immature mirids by five, dark, dorsal spots (one surrounding the scent gland opening, and a pair each on the pro- and mesothorax) and a dark spot at the base of the propleura. The base of the tibia ('knee') is also conspicuously dark. Alfalfa bugs, *Adelphocoris* spp., are frequently collected with *Lygus* species in alfalfa but can be distinguished from lygus bugs by the numerous black spots on the legs, the mostly pale, unmarked, general coloration, and the longer antennal segments with the apex and base of segment 4 strongly narrowed.

The five instars are most easily differentiated by overall length, size of the head capsule, length of the labium and antennal segments, and the development of the wing pads. The morphological differences between the instar stages of the three agriculturally important species of *Lygus* are slight, except for diagnostic differences in color and antennal segment length. However, these differences are at least as variable as the color variation encountered in the conspecific adult stages. The instar stage observations presented herein are based on specimens taken from cultures in Winnipeg, Manitoba (*L. borealis* and *L. lineolaris*), Lethbridge, Alberta (*L. elisus*), Shafter, California (*L. elisus* and *L. hesperus*), and Berkeley, California (*L. hesperus*).

Generally the color of specimens from culture is paler than that of field collected specimens. Instars collected from the Prairies (see Schwartz and Foottit 1992 for localities) were also examined to incorporate the range of color variation encountered in the field. Schwartz and Foottit (1992) surveyed lygus bugs from oilseed *Brassica* fields in the Prairies. The overwhelming majority of the instars collected in that

survey were *L. borealis*, *L. elisus*, and *L. lineolaris*. Instars of *L. shulli* taken from testplots of the Lethbridge Research Station; a diagnosis and descriptions of instars 3-5 are included for this species. Although *L. hesperus* was not collected by Schwartz and Foottit (1992) and is not known to occur in the Prairies (Kelton 1975, 1980), we include a diagnosis, illustrations, and measurements of the instars of this widespread western species for comparison with the other agriculturally important species. The following key and descriptions will differentiate the instars and the key to instars 4 and 5 and diagnoses in the species treatments will document the specific characteristics. Separation of the instars of *L. borealis* and *L. elisus* is problematic. It is necessary to further substantiate the instar diagnoses of these two species by starting colonies using positively identified adults from several more prairies localities.

Key to the nymphal stages of *Lygus*

1. Wing pads undeveloped, thoracic segments subequal in length and width; length of antennal segment 4 longer than or equal to length of segment 2; dorsally without two pairs of black thoracic spots and a black spot surrounding the aperture of the dorsal gland (the aperture sometimes narrowly black), and laterally without black spot on propleura ... 2

— Wing pads developed, meso- and metathorax differentiated from prothorax, either rectangular (or slightly indented) and overlapping the base of the abdomen or projecting backward and reaching abdominal tergites 3 or 4; length of antennal segment 2 longer than length of either segment 3 or 4; dorsally with two pairs of black thoracic spots (sometimes instar 3 without spots) and a black spot surrounding the aperture of the dorsal gland, and sometimes laterally with black spot on propleura 3

2. Antennal segment 4 subequal to combined length of segments 2 and 3; vestiture consisting of a few bands of equal length primary setae; head width less than 0.43 ..... Instar 1

— Antennal segments 4 and 2 subequal; vestiture consisting of a few bands of setae composed of primary setae separated by several shorter secondary setae; head width greater than 0.45 . ..... Instar 2

3. Posterior margin of metathoracic wing pad straight, mesothoracic wing pad indented (Fig. 12); mesothoracic wing pad overlapping metathoracic wing pad at base, metathoracic wing pad overlapping abdomen at base; propleura without dark spot; head width less than 0.74 ..... Instar 3

— Posterior margin of wing pads deeply concave, mesothoracic wing pad overlapping metathoracic wing pad at base and lateral margins, both wing pads overlapping abdomen to tergite 3 or 4; propleura with dark spot; head width greater than 0.74 4

4. Apices of metathoracic wing pad visible and reaching tergite 3; lateral margin of wing pads straight (Fig. 13); length of antennal segment 3 usually longer than segment 4 (in *L. lineolaris* segment 4 is subequal to segment 3) .. Instar 4

— Apices of metathoracic wing pad covered by mesothoracic pad, and reaching sternites 4 or 5; lateral margin of wing pads convex; length of antennal segment 3 always longer than segment 4 ..... Instar 5

Diagnosis of *Lygus* nymphal stages

Instar 1

Dorsally with equal length, brown or black primary setae on vertex, near eye and antennal insertion, on antennal segment 1, in single transverse rows on each abdomen segment, and bordering darkened patches on thorax. General color pale yellow, yellow green, or green with dark markings either red, brown, or black on antenna, frons, thorax bilaterally on dorsum and in ventral aspect, coxa, tibia (especially basally at 'knees'), and tarsus. Length of antennal segments with 4>2>3>1. Thorax with pro- and mesothorax approximately with the same length and width, usually with maximum width narrower than width of head across eyes, lateral margin curved; metathorax not as wide as first two segments. Dorsal scent gland opening located medially between abdominal segments 3 and 4, aperture complete, without surrounding dark mark. Apex of labium reaching from the base to the middle of the abdomen.

Instar 2

As instar 1 except: vestiture with shorter, brown or black secondary setae situated between longer primary

setae; dark markings with deepened intensity, dorsal patches separated by wider, pale stripe; femur usually with dark infuscation; length of antennal segments 4≥2>3>1; thorax with prothorax wider than width of head across eyes and with length about as long as mesothorax; meso- and metathorax slightly overlapped and wider than prothorax; aperture of scent gland opening surrounded by dark mark; apex of labium reaching base of abdomen.

Instar 3

As instar 2 except: vestiture more scattered on thorax, the distinction between primary and secondary setae less obvious; dark marking more extensive, sometimes with a pair of black spots on prothorax (pronotum) and on mesothorax (scutellum); dorsal scent gland opening within larger black spot; femur with dark stripe apically; length of antennal segments 2>4≥3>1; meso- and metathorax flattened, rectangular, expanded posteriorly, forming wing pads that overlap the abdomen basally, forewing pad overlapping hindwing pad only on base.

Instar 4

As instar 3 except: vestiture more scattered on all body regions; propleuron with black spot; head, thorax and wing pads with diffuse, darkened pattern; abdominal segments 2 and 3 with dark transverse markings; femur with two stripes apically; length of antennal segments 2>3>4>1; lateral margins of wings pads straight, wing pads reaching abdominal segment 3, mesothoracic pad overlapping metathoracic pad on base and lateral margin. Sex determined by differential development of the sclerotized plate on the ninth abdominal sternite; male with sternite quadrate, female with sternite bifurcated by suture of developing ovipositor.

Instar 5

As instar 4 except: all abdominal segments with transverse dark markings; lateral margins of wings pads curved, wing pads reaching abdominal segment 4 or 5, mesothoracic pad overlapping metathoracic pad except for interior margin. Sternite of male complete (Fig. 37), sternite of female with medial suture (Fig. 38).

Key to the species of *Lygus* instars 4 and 5

1. Body with extensive and variable bright or dark red, red brown or brown markings on head (especially submedian stripe of frons and medial stripe of tylus; submedian stripe sometimes reduced to pale brown spot(s)), thorax laterally, abdomen dorsally and ventrally, and legs; antennal segment 4 in instar 4 equal to segment 3 (segment 4 0.64-0.71 and segment 3 0.65-0.74), in instar 5 segment 4 ranges from 0.71 to 0.88; coloration of antennal segment 2 usually with red or brown apex and base otherwise mostly infuscate; if segment 2 darkly infuscate then length usually less than 0.96 in instar 4 and less than 1.35 in instar 5 .... *L. lineolaris* (Palisot de Beauvois)

— Head, thorax, and abdomen either without extensive and various red markings or if such markings are present on thorax and abdomen laterally then frons without submedian stripe; antennal segment 4 in instar 4 usually shorter than segment 3 (segment 4 0.50-0.65 and segment 3 0.58-0.79), in instar 5 segment 4 ranges from 0.57 to 0.67; coloration of antennal segment 2 variable, either unicolorous brown or red, or distinctly bicolorous red and pale 2

2. Length of antennal segment 2 in instar 4 0.81-0.99 and in instar 5 1.10-1.39; coloration of antennal segment either unicolorous pale to dark brown or red, or distinctly bicolorous red and pale 3

— Length of antennal segment 2 in instar 4 0.95-1.17 and in instar 5 1.35-1.62; coloration of antennal segment 2 unicolorous dark red . 4

3. Antennal coloration in instars 4 and 5 unicolorous with segments 3 and 4 brown, segment 2 is either brown, infuscate brown or mostly pale, and segment 1 infuscate brown; general coloration pale yellow green, dark markings on dorsum and legs usually brown .... *L. borealis* (Kelton)

— Antennal coloration in instars 4 and 5 with apex of segment 1, the basal and apical one-third of segment 2, and segments 3 and 4 bright or dark red; bicolorous segment 2 with contrast between the pale and red areas; general

coloration pale yellow, dark markings on dorsum and legs usually red .... *L. elisus* Van Duzee

4. Width of head across eyes in instar 4 0.95-1.01 in instar 5 1.14-1.16; length of metatibia 1.55-1.69 in instar 4 and from 2.23 to 2.36 in instar 5; head, thorax laterally, and abdomen without red markings; body conformation (shape as in Figures 35, 36) . *L. shulli* Knight

— Width of head across eyes in instar 4 0.78-0.89 in instar 5 from 0.99 to 1.12; length of metatibia 1.34- 1.52 in instar 4 and from 2.04-2.25 in instar 5; femur, head, thorax laterally, and abdomen with red markings; body conformation elongate (Figs. 49, 50) .... *L. hesperus* Knight

Lygus borealis (Kelton)

Figs. 4, 5-15

Liocoris borealis Kelton, 1955b: 488; 1955c: 548.
Lygus borealis: Carvalho, 1959: 148; Kelton, 1975: 40; 1980: 125; Henry and Wheeler, 1988: 321.

Diagnosis of adults

Distinguished from *L. elisus* (usually the only other green species in agricultural situations) by the anterior black mark on the propleuron, the flattened aspect of the pronotum and scutellum, the slightly protruding anterior angles of the pronotum in lateral view (Fig. 4), the unicolorous mesoscutum (in some *L. elisus* the mesoscutum is unicolorous), and the uniformly green cuneus (sometimes the tip of the cuneus is black). The summer adults of *L. borealis* are also separated from *L. elisus* by the shining, mostly translucent pronotum and hemelytra with short, sparse vestiture and the shallow and sparse punctures of the pronotum (Fig. 5). *Lygus borealis* is separated from *L. nigropallidus* Knight by the smooth frons usually with red markings and from *L. lineolaris* by the abscence of the submedian stripe on the frons.

Variation

Figures 6-9. Usually there are two black spots posterior to the callus, (one at the middle, one at the lateral end); usually the most pale-colored female will maintain a hint of a slight lateral spot. In darkly colored specimens the spots tend to streak posteriorly and may merge with the dark stripe on the posterior margin of the pronotum. Pale summer females usually have only the base of the median line of the scutellum present.

Overwintered generation The overall aspect of the dorsum is opaque, especially the pronotum. The pale areas are dingy orange yellow. The antennal segments are orange brown; the ventral side of segment 1 and the base of segment 2 are black.

Summer generation(s) The overall aspect of the dorsum is translucent and shiny. The pale areas are yellow green. The extent and intensity of the black, dark brown or red markings vary on the antennal segments (sometimes completely black), tylus, jugum, frons, triangular patch dorsal to the antennal insertion and adjacent to the eye, labial segment 4, just interior to the anterior angles and posterior margin of the pronotum, callus and two marks posterior to the callus, median line (and sometimes lateral line) of the scutellum, middle of the clavus, apex of the cubitus and radius vein, paracuneus, interior margin and apex of the cuneus, membrane near apex of the large areole, apex of the femur, base of the tibia, tarsal segment 3, and venter.

The females are usually paler in color, with reduced black or red markings; the dark mark on the propleuron of some females may be greatly reduced.

Diagnosis of nymphal stages

Distinguished from *L. elisus* by the antennal coloration: in instars 1-3 all segments are uniformly brown; in instars 4 and 5 segments 3 and 4 are brown, segment 2 is either brown, infuscate brown or mostly pale, and segment 1 is infuscate brown. The almost concolorous antennal segments of this species are in contrast to the red and pale bicolored antennal segment 2 of *L. elisus*. In freshly collected specimens,y the brown antennae can be tinged with red. The tibiae, exclusive of the base, and tarsi of all stages are usually brown, except in instar 5 where the tibiae are mostly pale. The dark brown or red brown knee region of all instars is separated from the rest of tibia by a pale space. The ground color of all instars including the frons is pale yellow, or pale yellow green; the more sclerotized regions are usually pale brown. The patterning on the wing pads and pronotum of instars 4 and 5 is sometimes faint; the wing pads apices are usually tinged with dark brown. Antennal structure (segment 4 short and segmental comparisons) will distinguish of *L. borealis* from *L. lineolaris* (see Diagnosis of *L. lineolaris*).

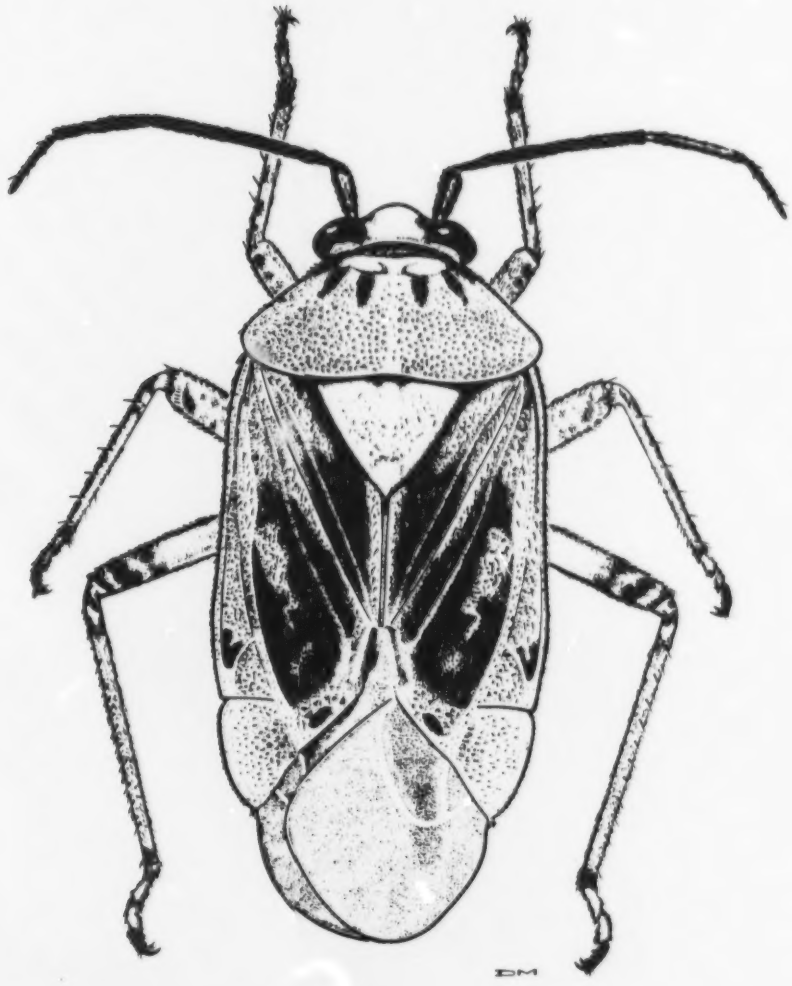
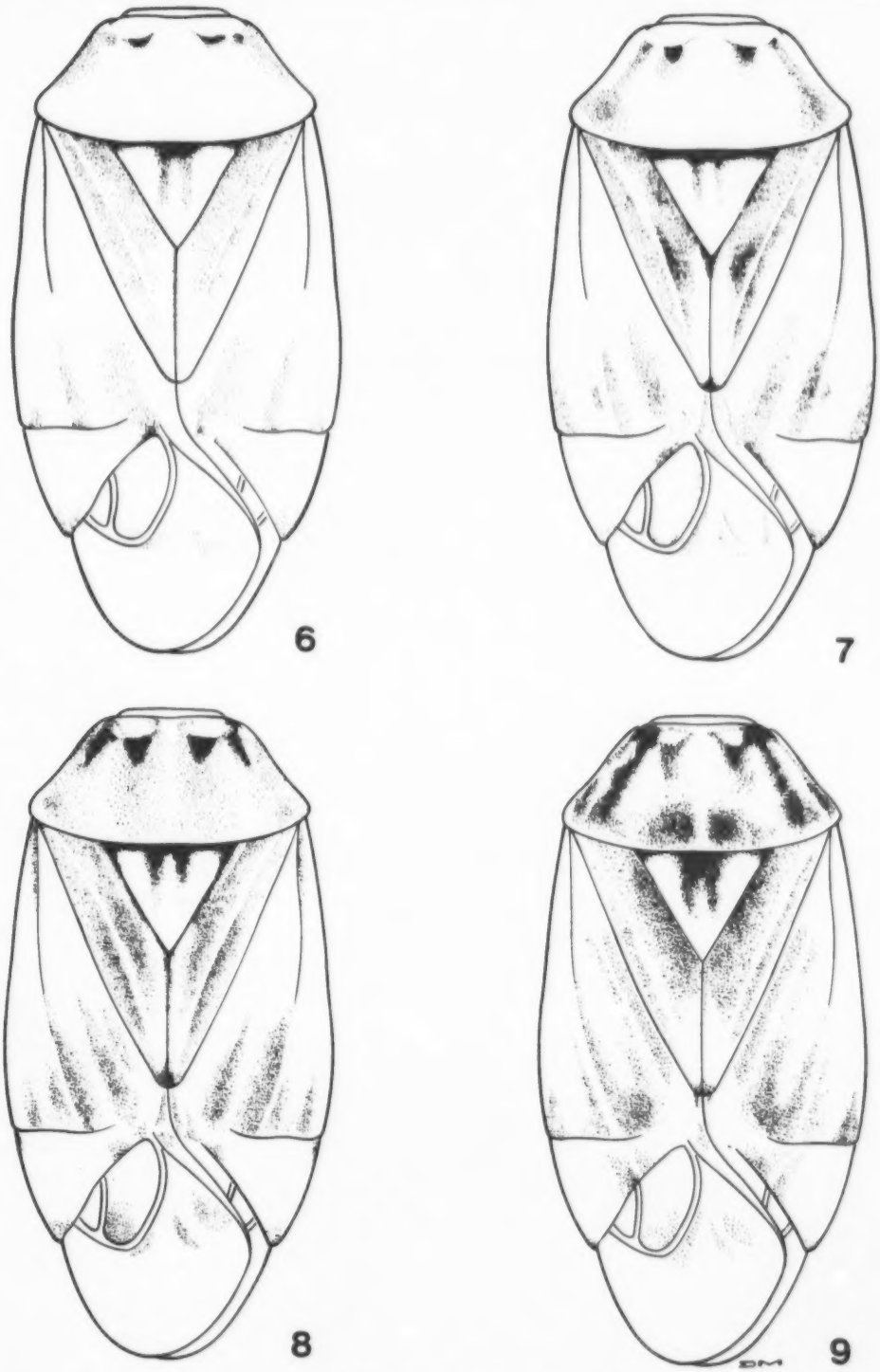


Fig. 5 *Lygus borealis* (Kelton), male dorsal habitus, Russell, MB.



Figs. 6-9 *Lygus borealis* (Kelton), variation of dorsum. 6. Hanley, SK. 7. Hanley, SK. 8. Carberry, MB. 9. Elkwater, AB.

Description of nymphal stages

Instar 1 Figure 10. Maximum length 1.02-1.24; width of head across eyes 0.36-0.43. General coloration: pale yellow; antennal segments, bilateral patches on head, dorsal and ventral aspect of the thorax, aperture of dorsal scent gland, labial segment 4, tibia (darkest basally), and tarsus dark brown or black; dark areas on dorsum bisected by pale median stripe, head with pale 'V' shaped marking. Vestiture: with rings of equal length, black primary setae. Length of antennal segments: 4 two-thirds longer than 2 or 3, 3 subequal to 2; length 1, 0.10-0.13; 2, 0.24-0.28; 3, 0.22-0.25; 4, 0.33-0.38. Length of labium 0.67-0.79, apex reaching from base to middle of abdomen. Length of metatibia 0.48-0.56.

Instar 2 Figure 11. Maximum length 1.34-1.68; width of head across eyes 0.49-0.55. General coloration as instar 1 except: dorsal markings paler, femur with darker infuscation. Thorax wider than instar 1. Length of antennal segments: 2 subequal to 4, 2 and 4 longer than 3; length 1, 0.12-0.18; 2, 0.39-0.43; 3, 0.29-0.36; 4, 0.34-0.45. Vestiture: with rings of primary setae intermixed with shorter, secondary setae, midline of abdomen without setae. Length of labium 0.80-1.00, apex reaching base of abdomen. Length of metatibia 0.55-0.76.

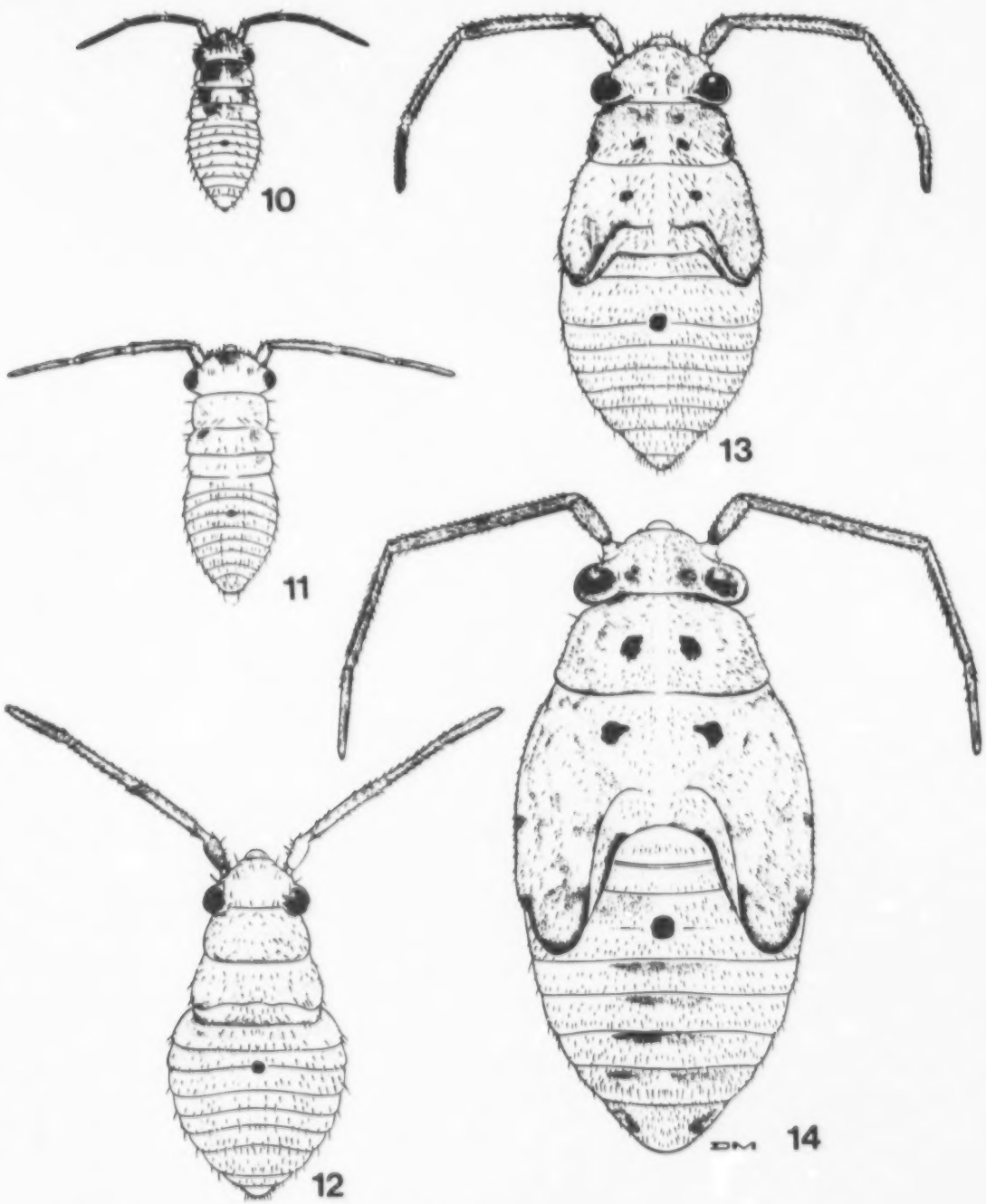
Instar 3 Figure 12. Maximum length 1.80-2.55; width of head across eyes 0.64-0.72. General coloration as instar 2 except: head and thorax with brown infuscation; older specimens with pair of black spots on pro- and mesothorax. Meso- and metathorax flattened and expanded posteriorly, forming wing pads that overlap base of abdomen. Dorsal scent gland aperture surrounded by large black spot; aperture overlapping in middle. Femur with one complete and one obscure apical band. Vestiture: abdomen with rings of primary and secondary setae, each abdominal segment with one ring, thorax also with scattered, short setae in addition to rings of setae. Length of antennal segments: 2 one-fifth longer than 3 or 4, 3 and 4 subequal; length 1, 0.19-0.23; 2, 0.56-0.66; 3, 0.45-0.52; 4, 0.43-0.52. Length of labium 1.22-1.38, apex reaching base of abdomen. Length of metatibia 0.89-1.05.

Instar 4 Figure 13. Maximum length 2.03-3.14; width of head across eyes 0.80-0.89. General coloration: pale, yellow green; head and thorax with dark patterning mesially, two pairs of thorax spots and spot broadly surrounding dorsal scent gland opening prominent and black; propleuron with large, dark mark. Wing pads reaching abdominal segment 3. Lateral margin of thorax straight, mesothorax overlapping but not obscuring metathorax. Femur with two dark, apical bands, tibia dark apically. Length of antennal segments: 2 longer than 3, 3 longer than 4; length 1, 0.25-0.30; 2, 0.83-0.92; 3, 0.61-0.70; 4, 0.50-0.57. Vestiture: abdomen with rings of various length setae, each segment with two rings, thorax with scattered, short setae. Length of labium 1.56-1.69, apex reaching base of abdomen. Length of metatibia 1.30-1.38.

Instar 5 Figure 14. Maximum length 2.98-4.45; width of head across eyes 0.99-1.11. General coloration as instar 4 except: head, thorax, and abdomen with more extensive dark patterning, five black dorsal spots prominent. Wing pads reaching abdominal segment 5. Lateral margin of thorax convex, mesothorax overlapping and obscuring apex of metathorax. Length of antennal segments: 2 longer than 3, 3 longer than 4; length 1, 0.34-0.41; 2, 1.12-1.28; 3, 0.76-0.89; 4, 0.57-0.65. Vestiture: abdomen with rings of various length setae, each segment with two rings, thorax with scattered, short setae. Length of labium 1.93-2.04, apex reaching base of abdomen. Length of metatibia 1.67-1.96.

Host plants

Asteraceae: *Achillea millefolium* L. (Domek and Scott 1985, Schwartz and Foottit 1992), *Anaphalis margaritacea* (L.) C. B. Clarke (Domek and Scott 1985), *Antennaria aprica* Greene, and *Artemisia frigida* Willd. **Brassicaceae**: oilseed rape (*Brassica campestris*, *B. napus*) (Butts and Lamb 1991a, Schwartz and Foottit 1992), mustard (*B. juncea* (L.) Coss.), mustard (*Sinapis alba* L., *S. arvensis* L.) (Schwartz and Foottit 1992), and *Capsella bursa-pastoris* (Domek and Scott 1985, Schwartz and Foottit 1992). **Caprifoliaceae**: *Symphoricarpos occidentalis* Hooker (Domek and Scott 1985). **Caryophyllaceae**: *Gypsophila paniculata* L. (Schwartz and Foottit 1992). **Fabaceae**: alfalfa (Butts and Lamb 1991a, Craig 1983, Schwartz and Foottit 1992), sainfoin (*Onobrychis viciifolia* Scop.) (Morrill et al. 1984), birdsfoot-trefoil (*Lotus corniculatus* L.), sweet clover (*Melilotus alba* Desr.), and *Lupinus argenteus* Pursh (Schwartz and Foottit 1992). **Rosaceae**: *Sanguisorba minor* Scopoli (Domek and Scott 1985).



Figs. 10-14 *Lygus borealis* (Kelton), nymphal stages, dorsal habitus. **10.** Instar 1. **11.** Instar 2. **12.** Instar 3. **13.** Instar 4. **14.** Instar 5.

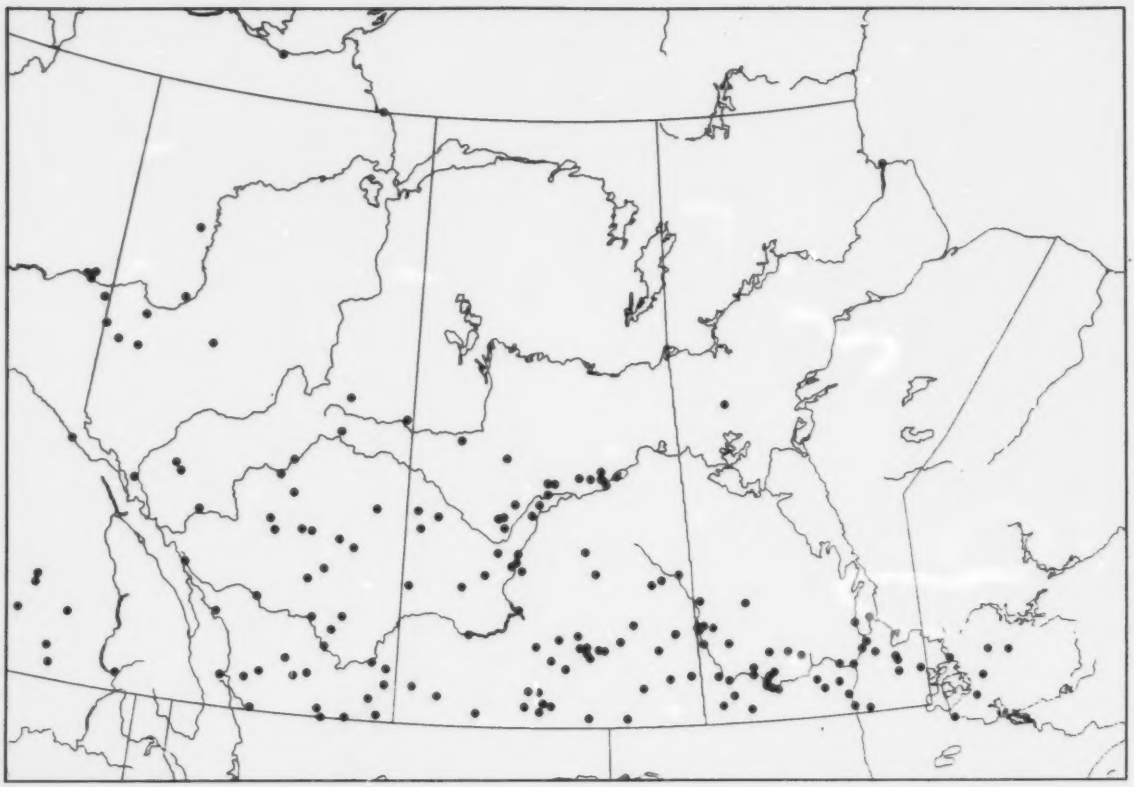


Fig. 15 Distribution of *Lygus borealis* (Kelton).

Discussion Sainfoin has several desirable characteristics that make it a potential alternative to alfalfa as a forage crop (Morrill et al. 1984). But as with alfalfa (Bolton and Peck 1946, Craig 1983), seed production of sainfoin is negatively correlated with population densities of *L. borealis* (Morrill et al. 1984). Butts and Lamb (1991a) reported that the relative abundance of *L. borealis* on alfalfa is greater than that of *L. elisus* and *L. lineolaris*. Some of the earlier studies of *Lygus* infesting alfalfa (Salt 1945, Shull et al. 1934) may refer to *L. borealis* (Kelton 1975).

Distribution

This mostly boreal species occurs widely in northern North America from east central Alaska to the Mackenzie River in the Northwest Territories southeast through the Prairies of Canada and the United States to Iowa. Specimens are also known from eastern Canada and the Rocky Mountains.

Prairie collections Figure 15. ALBERTA: Aden; Aspen Beach; Banff; Barons; Bassano; Beaverlodge; Bellis; Blackfoot Hills; 14.3 km SE of Brooks; Calgary; Calmar; Castor; Chin; Coal Valley; Cold Lake; Coronation; Coutts; Cowley; Craigmyle; Cypress Hills Prov. Park; Demmitt; 3.8 km N of and 3.8 km S of Drumheller; Edmonton; Elkwater; Empress; Fairview; Fisher Creek; Frank; Grand Prairie; Grimshaw; High Prairie; Irvine; Jasper National Park; Kananaskis; Lac la Biche; Lethbridge; Lundbreck; Manyberries; Fort McMurray; Medicine Hat; Milk River, 49° 8′N 110° 48′W; Nevis; Nordegg; Onefour; Peace River; Pincher Creek; Red Deer; Robb; Rycroft; Scandia; Spring Point; Stettler; Steveville; Valleyview; Vegreville; Wainwright; Waterton Lakes National Park; Wetaskiwin. MANITOBA: Angusville; Aweme; Beausejour; Boissevain; 6 mi NW of Brandon; Brunkild; Carberry, 10 km W of, and 15 km S of; Carman; Churchill; Dauphin; Deer River; Deloraine; 2 mi E of Douglas; Elma; Falcon Lake; 2 mi N of Forrest; Fort Garry;

Foxwarren; 2.5 km NW of and 5 km NW of Gillam; Gimli; 3.4 km W of Gladstone; 13 mi N of and 15 mi N of Glenboro; Harrowby; Hartney; Haywood; Horton; Libau; Millwood; 5 mi N of Minnedosa; Morris; 3.0 km E of Neepawa; Ninette; Napinka; 4.7 km E of Oak Lake; Onah; Portage la Prairie; Prawda; Reynolds; Roblin and 10 mi W of; Roseau River; Russell and 6.4 km W of; Selkirk; 3 mi S of and 5 mi SW of Shilo; Shoal Lake and 7 km SE of; St. Francois Xavier; St. Lazare; Stockton; 2 mi W of and 4.7 km E of Tolstoi; Treesbank; Turtle Mountain; Venables; Victoria Beach; Virden and 5 km NW of; Westbourne; Whitemouth; Winnipeg. SASKATCHEWAN: Albertville; Asadene; Asquith; Assiniboia; Battle River; Beaver Creek; Bestville; Big River; Broadview; Buffalo Pound Prov. Park; Buttress; Candle Creek; Canora; Choiceland; Claybank; Cut Knife; Cypress Hills Prov. Park; Davin; 3.5 km NE of Delisle; Duck Lake and 10 km S of; Dundurn; Eastend; Elbow; Englefeld; Esterhazy; Estlin; 7 km W of Fairlight; Garrick; Gascoigne; Good Spirit Lake Prov. Park; 8 km W of Grand Coulee; Great Deer; Great Sand Hills; 10 km SE of Hanley (186 km N of Regina); Harris; Indian Head; Jameson; Kandahar; Kenosee Lake; Krydor; La Ronde; Leask; Limerick; Lisieux; Lorlie; Love; Lumsden; Macdowall; Marengo; McGee; Meadow Lake; 5.0 km E of Melville; Minton; Mortlach; Neilburg; Nipawin, 14.2 km S of, and 37.9 km S of; Pas Trail; Pike Lake; Pipestone Creek; Preeceville; Prince Albert and 7 km N of; Qu'Appelle; Redberry; Regina; Rockglen; Rowatt; Rutland; St. Victor; Saskatchewan Landing; Saskatoon and 62.0 km SW of; 10.7 km S of Smeaton; Springside; Spruce Home; 35.4 km N of and 45.8 km N of Stoughton; Torch River; Torquay; Tunstall; Val Marie; White Fox; Willow Bunch; Wood Mountain; 30 km NE of Zealandia.

Lygus elisus Van Duzee

Figs. 3, 16-26

Lygus pratensis var. *elisus* Van Duzee, 1914: 20.
Lygus elisus: Van Duzee, 1916: 40; Kelton, 1975: 36; 1980: 133; Carvalho, 1959: 148; Henry and Wheeler, 1988: 323.
Lygus (*Lygus*) *elisus* var. *viridiscutatus* Knight, 1917: 575. Synonymized by Kelton, 1975: 36.
Lygus nigrosignatus Knight, 1941b: 270. Synonymized by Kelton, 1975: 37.
Lygus desertus Knight, 1944: 471; Carvalho, 1959: 148; Henry and Wheeler, 1988: 322. Synonymized by Lattin et al. 1992: 20.
Liocoris nigrosignatus: Kelton, 1955c: 552.
Liocoris elisus: Kelton, 1955c: 548.
Liocoris desertus: Kelton, 1955c: 548.
Lygus desertinus Knight, 1968: 189; Kelton, 1975: 38; 1980: 119. Unnecessary new name (see Lattin et al. 1992: 13).

Diagnosis of adults

Usually this species, and *L. borealis*, are the only green species collected from agricultural situations. Specimens of *L. elisus* with the lateral margins of the mesoscuta pale and the median section black are readily distinguished from *L. borealis* which have completely black mesoscuta. Specimens of *L. elisus* with black mesoscuta are distinguished from *L. borealis* by the rounded anterior angles of the pronotum, in lateral view, the usually unmarked propleuron anteriorly, and the usually black cuneal apex. The longer and more densely distributed vestiture (Fig. 16) of the usually non-translucent hemelytra and the deeper more densely distributed punctures of the pronotum of *L. elisus* will further separate this species from *L. borealis*. Dark specimens of *L. elisus* (Fig. 20) may be confused with small specimens of *L. rubrosignatus*; however, the former species is separated by the rounded anterior angles of the pronotum, the longer antennal segment 2, and the shorter labium which typically does not reach the apices of the mesocoxae.

Variation

Figures 17-20. Specimens collected from the north, at higher elevations, and early or late in the season, are typically more darkly marked; specimens collected from the south, at lower elevations, and in the summer are typically less darkly marked. Females are usually less darkly marked than males. There is usually one black spot posterior to the middle of a callus. Darkly colored specimens have two spots as in *L. borealis*. There is less of a tendency for the spots to streak posteriorly as in *L. borealis*, but the spots never merge with the dark markings on the posterior margin of the pronotum. It is difficult to discern overwintered and summer generations of this species; the presence of green color often distinguishes the summer generation(s), and the overwintered generation is recognized by the more extensive dark markings, especially on the frons.

Overwintered generation General coloration is pale orange yellow. The dark brown or black markings are

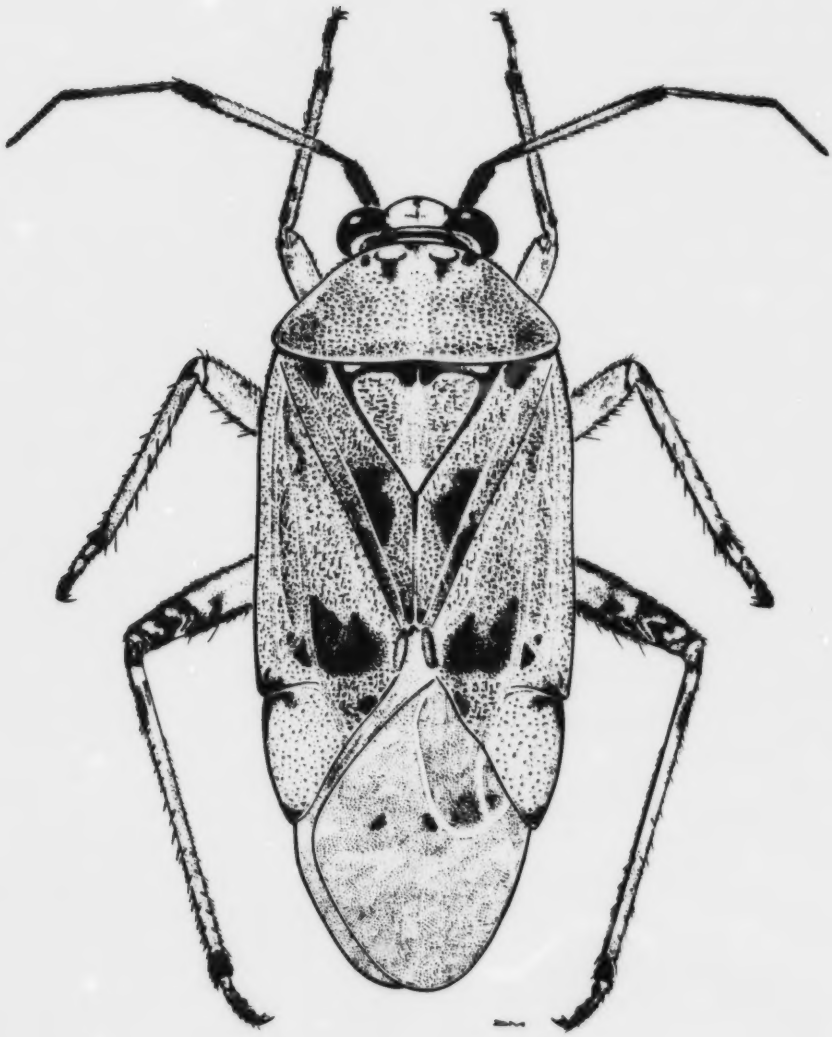
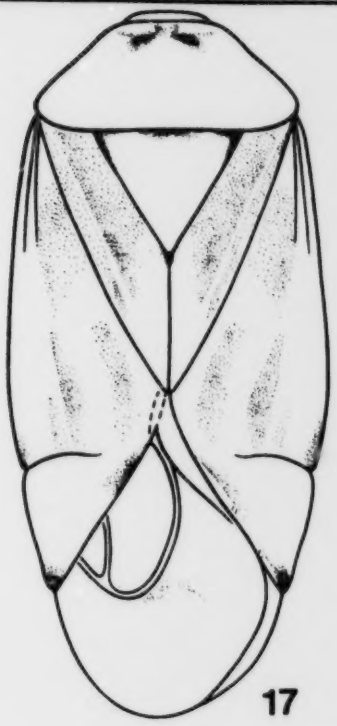
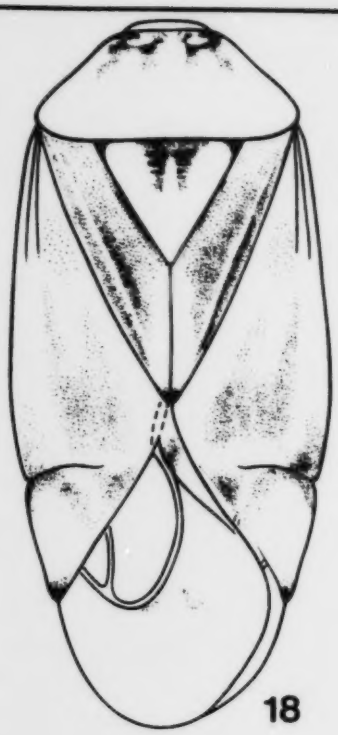
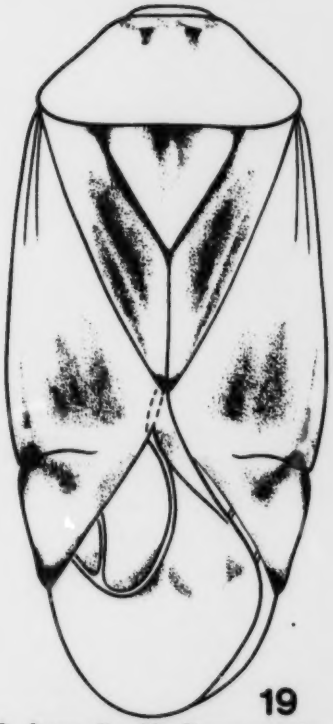
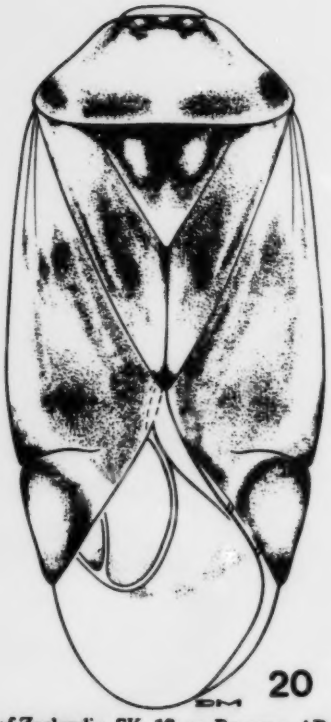


Fig. 16 *Lygus elisus* Van Duzee, male dorsal habitus, Winnipeg, MB.









Figs. 17-20 *Lygus elisus* Van Duzee, variation of dorsum. 17. 30 km NE of Zealandia, SK. 18. nr. Bassano, AB. 19. 24.7 km W of Fairlight, SK. 20. Miracle Beach, nr. Oyster River, BC.

more extensive than the summer generation(s) and vary in extent and intensity the following structures: antennal segments 1 and the base of 2 (segment 2 is never completely black), gula, tylus, jugum, frons, triangular patch dorsal to the antennal insertion and adjacent to the eye, labial segment 4, just interior to the anterior angles and posterior margin of the pronotum, callus and two marks posterior to the callus, anterior portion of the propleuron, medial and lateral lines of the scutellum, middle and apex of the clavus, adjacent to the cubitus and radius vein, lateral margin of the embolium, paracuneus, periphery and apex of the cuneus, membrane near apex of the large areole (very small mark), middle of the femur, base of the tibia, apex of tarsal segment 3, and median portion of the venter.

Summer generation(s) The general pale coloration is yellow green. Head usually lacking the black and red markings and the ventral aspect is almost entirely yellow green. Pale summer females lack the entire median line on the scutellum.

Diagnosis of nymphal stages

Distinguished by the red markings on the antenna; in *L. borealis* the antenna is usually brown or dark brown. In instars 1 and 2 antennal segments 4 and 3 and the apical and basal third of segment 2 are red. The base color of the segments including segment 1 is pale yellow to brown. In instars 3-5 the apex of segment 1, the basal and apical one-third of segment 2, and segments 3 and 4 are red, but there is greater contrast between the pale and red areas. The tibiae of all stages are infuscate brown with dark brown knees; in instars 4 and 5 a subapical band and the apex are dark brown. The dorsal pattern on the pronotum and wing pads of instars 4 and 5 are usually pale brown. Antennal structure (segment 4 short and segmental comparisons) will distinguish *L. elisus* from *L. lineolaris* (see Diagnosis of *L. lineolaris*).

Description of nymphal stages

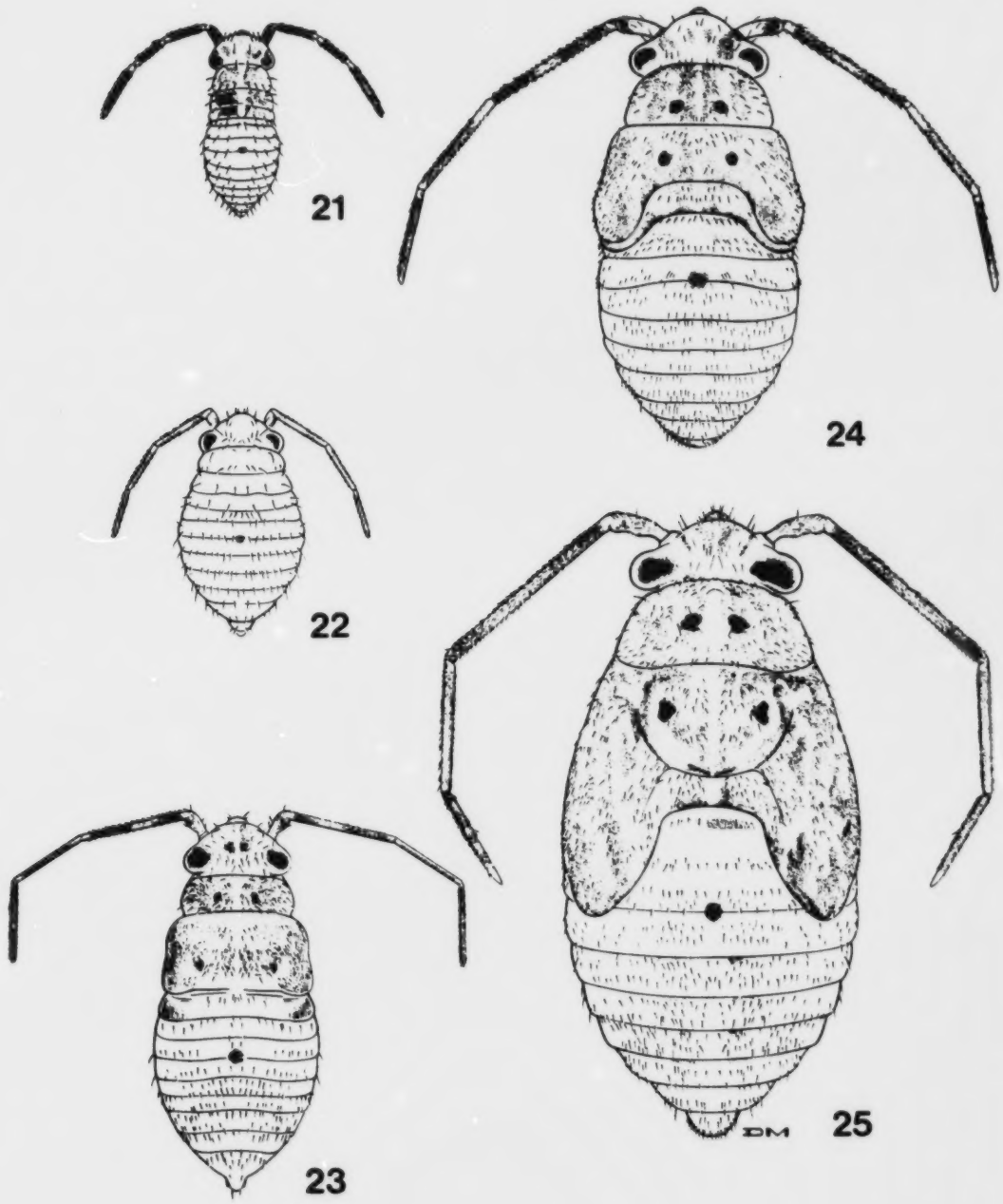
Instar 1 Figure 21. Maximum length 0.91-1.41; width of head across eyes 0.35-0.42. General coloration: pale yellow or yellow green; dark brown markings on antennal segments 1-3 (segment 2 concolorous), head, dorsal and ventral aspects of the thorax, tibia, and tarsus (femur pale brown without dark stripes at apex); labium with segment 1 brown laterally, segment 4 apically; red on antennal segment 4 and base of tibia (red mark separated from the remainder of tibia by pale space); dorsal scent gland with aperture only dark. Vestiture: with primary setae only. Length of antennal segments: 4 two-thirds longer than 2 or 3, 3 subequal to 2; length 1, 0.09-0.13; 2, 0.21-0.30; 3, 0.19-0.26; 4, 0.30-0.37. Length of labium 0.66-0.79, apex reaching from base to middle of abdomen. Length of metatibia 0.43-0.55.

Instar 2 Figure 22. Maximum length 1.34-1.74; width of head across eyes 0.47-0.53. General coloration as instar 1 except: tarsus darker, antennal segments 2-4 red (segment 2 sometimes without red medially), aperture of dorsal scent gland surrounded by black mark, femur with apical and subapical pale markings giving striped appearance. Vestiture: with primary and secondary setae. Length of antennal segments: 2 subequal to 4, 3 one-fifth shorter than 2 or 4; length 1, 0.12-0.16; 2, 0.35-0.44; 3, 0.29-0.36; 4, 0.35-0.44. Vestiture: Length of labium 0.88-0.99, apex reaching base of abdomen. Length of metatibia 0.58-0.68.

Instar 3 Figure 23. Maximum length 1.49-2.24; width of head across eyes 0.61-0.68. General coloration as instar 2 except: antennal segment 2 pale medially, apex and base red; segment 3 with apex and base pale; femur paler except for two dark apical stripes. Vestiture: abdomen with bands of primary and secondary setae, otherwise with scattered setae. Length of antennal segments: 2 one-fifth longer than 3 or 4, 3 and 4 subequal; length 1, 0.15-0.21; 2, 0.51-0.69; 3, 0.40-0.52; 4, 0.40-0.52. Length of labium 1.07-1.29,apex reaching base of abdomen. Length of metatibia 0.90-1.00.

Instar 4 Figure 24. Maximum length 2.29-2.77; width of head across eyes 0.74-0.88. General coloration: as instar 3 except thorax with dark patterning, tibia pale except for red base and dark subbasal and apical bands. Length of antennal segments: 2 longer than 3, 3 longer than 4; length 1, 0.23-0.29; 2, 0.81-0.99; 3, 0.58-0.69; 4, 0.51-0.64. Length of labium 1.35-1.59, apex reaching base of abdomen. Length of metatibia 1.22-1.40.

Instar 5 Figure 25. Maximum length 2.72-3.88; width of head across eyes 0.93-1.02. General coloration as instar 4 except markings are contrast more boldly with pale ground coloration. Length of antennal segments: 2 longer than 3, 3 longer than 4; length 1, 0.32-0.38; 2, 1.10-1.34; 3, 0.75-0.89; 4, 0.63-0.70. Length of labium 1.77-1.94, apex reaching base of abdomen. Length of metatibia 1.63-1.80.



Figs. 21-25 *Lygus elisus* Van Duzee, nymphal stages, dorsal habitus. **21.** Instar 1. **22.** Instar 2. **23.** Instar 3. **24.** Instar 4. **25.** Instar 5.

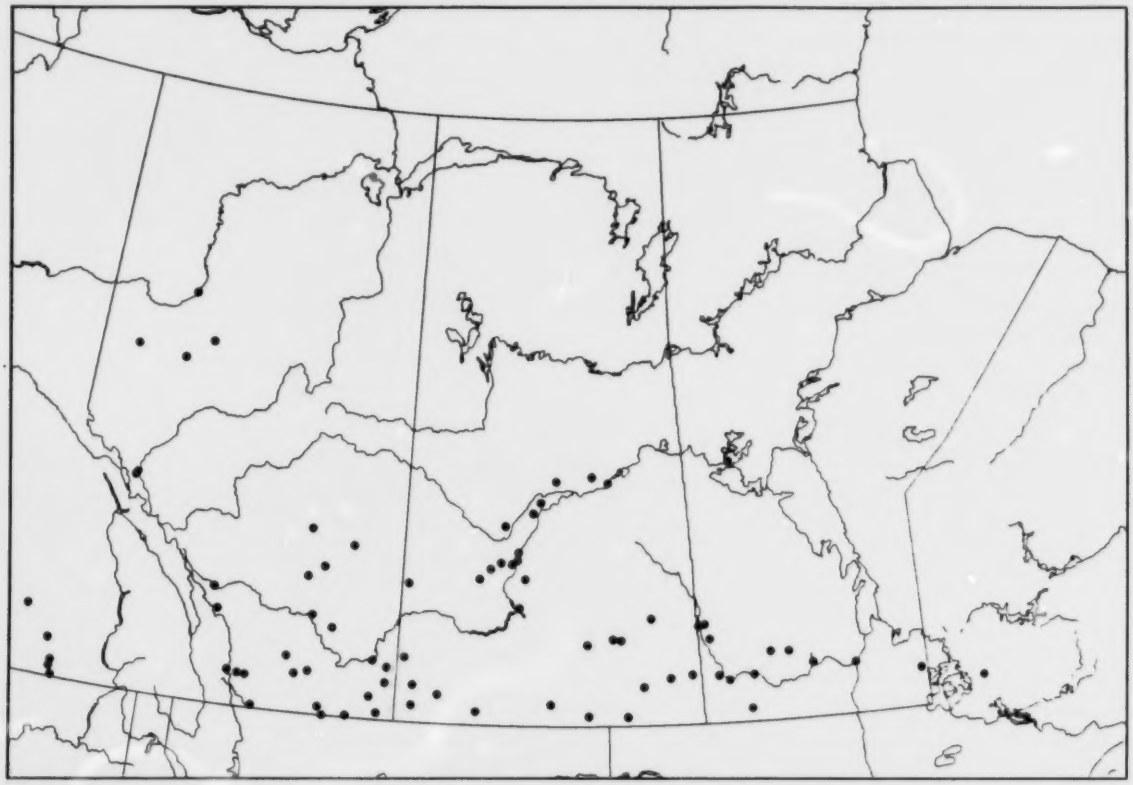


Fig. 26 Distribution of *Lygus elisus* Van Duzee.

Host plants[1]

Apiaceae: *Anthriscus scandicina* (Weber) Mansfeld [4]. **Asteraceae**: *Achillea millefolium* [4]; *Ambrosia artemisiifolia* [5]; *Anaphalis margaritacea* [4]; *Anthemis cotula* L. [4]; *Artemisia absinthium* L. [4]; *A. biennis* Wildenow [4]; *A. frigida* Willd. [8]; *Aster hesperius* Gray [4]; *Centaurea repens* L. [5]; *Chrysothamnus nauseosus* (Pall) Britton [4]; *Cichorium intybus* L. [4]; *Cirsium arvense* (L.) Scopoli [4,5]; *Conyza canadensis* [4,5]; *Grindelia squarrosa* (Pursh) Dunal [4]; *Helianthus annuus* L. [4,5]; *Iva xanthifolia* [4,5]; *Madia glomerata* Hooker [4]; *Solidago* spp. [5]; and *Xanthium strumarium* L. [4]. **Brassicaceae**: oilseed rape (*Brassica campestris*, *B. napus*) [2,8]; cabbage (*B. oleracea* L.) [6]; mustard (*B. juncea*) [8]; mustard (*Sinapis alba*, *S. arvensis*) [8]; *Capsella bursa-pastoris* [5,8]; *Cardaria draba* [5]; *Descurainia sophia* [5]; *Lepidium perfoliatum* L. [4]; *L. latifolium* [5]; and *Sisymbrium altissimum* [5]. **Caprifoliaceae**: *Symphoricarpos occidentalis* [4]. **Caryophyllaceae**: *Gypsophila paniculata* [8]. **Chenopodiaceae**: *Amaranthus retroflexus* [5]; *Beta vulgaris* L. [7]; *Chenopodium album* [4,5,7]; *C. botrys* L. [4]; *Kochia scoparia* [4]; *Salsola kali* L. [4,5,7]; and *Echinopsilon hyssopifolia* (Pall.) Moq. [7]. **Fabaceae**: alfalfa [1,2,3,4,7,8,10,13]; beans (*Phaseolus* spp.) [9]; sainfoin (*Onobrychis viciifolia*) [12]; birdsfoot-trefoil (*Lotus corniculatus*) [8]; white lupine (*Lupinus albus* L.) [11]; *L. argenteus* [8]; sweet clover (*Melilotus alba*) [4,8]; and red clover (*Trifolium pratense* L.) [5]. **Hypericaceae**: *Hypericum perforatum* L. [4]. **Lamiaceae**: *Mentha* spp. [7,8]. **Onagraceae**: *Epilobium angustifolium* L. [4]. **Polygonaceae**: *Eriogonum niveum* Douglas ex Bentham [4]; *Polygonum persicaria* L. [4,5]. **Rhamnaceae**: *Ceanothus sanguineus* Pursh [4].

[1] 1, Bolton and Peck (1946); 2, Butts and Lamb (1991a); 3, Craig (1983); 4, Domeck and Scott (1985); 5, Fye (1982a); 6, Getzin (1983); 7, Malcolom (1953); 8, Schwartz and Footit (1992); 9, Shull (1933a); 10, Shull et al. (1934); 11, Tanigoshi and Babcock (1989); 12, Wallace (1968); 13, Walstrom (1983).

Rosaceae: *Sanguisorba minor* [4]. **Scophulariaceae:** *Castilleja* sp. [4] and*Verbascum thapsus* [4]. **Solanaceae:** *Solanum sarrachoides* Sendl [4]. **Urticaceae:** *Urtica dioica* L. [4,7].

Discussion Although named the "pale legume bug," a comprehensive survey for hosts of *L. elisus* (Domek and Scott 1985) reported 34 host plants comprising 14 families. Pye (1982b) reported that *L. elisus* was the predominant species on weedy early-season crucifers, mid- and late-season chenopods, late blooming composites, and on the early vegetative stage of alfalfa. Butts and Lamb (1991a) reported that the relative abundance of three *Lygus* species varied between canola and alfalfa and that *L. elisus* showed a preference for *Brassica* species. That these workers have suggested that *L. elisus* shows a preference for crucifers provides support to similar observations from southern Arizona and southeastern California (Stitt 1949, Clancy 1968, Graham et al. 1982).

Distribution

Lygus elisus has the widest distribution in North America of any species of *Lygus* after *L. lineolaris*. It occurs from southeast and northern Alaska and the Mackenzie River delta of the Northwest Territories in the north to the United States/Mexican border and northern Mexico in the south. The range extends from the California coast and Vancouver Island east to approximately 100°W latitude. The easternmost locality is Story County, Iowa. Most collections are either from prairie-parkland or agricultural regions in or west of the Rocky Mountains.

Prairie collections Figure 26. ALBERTA: Aden; Aden, 25 mi E of Milk River; Barons; Bassano; Brooks and 14.3 km SE of; Budheart River; Canmore; Chin; Coronation; Coutts; Craigmyle; Crowsnest; Drumheller and 3.8 km N of; Elkwater; Fairview; Frank; Grande Prairie; High Prairie; Irvine; Jasper National Park; Pocahontas; Jasper; Kananaskis; Lethbridge; Lundbreck; Manyberries; Lost River; Fort McMurray; Medicine Hat; Milk River; Onefour; Peace River; Red Deer; Stettler; Valleyview; Vegreville; Waterton Lakes National Park MANITOBA: Boissevain; Brandon; Falcon Lake; 2.5 km NW of Foxwarren; 3.4 km W of Gladstone; Harrowby; Moose Lake; 3.0 km E of Neepawa; Ninette; 4.7 km E of Oak Lake; 1 km N of Portage la Prairie; 6.4 km W of Russell; 7 km SE of Shoal Lake; 6 km NW of Virden; Whitewater Lake; 4 mi N of Whitewater, Winnipeg. SASKATCHEWAN: Albertville; Beaver Creek; Choiceland; Consul; Cypress Hills Prov. Park; 3.5 km NE of Delisle; 10 km S of Duck Lake; Eastend; Elbow; 7 km W of Fairlight; Great Deer; 10 km SE of Hanley; Indian Head; Kenosee Lake; Macdowall; Marengo; 5.0 km E of Melville; Minton; 14.2 km S of Nipawin; Pike Lake; 10 km N of Qu'Appelle; 19 km W of Regina; Rockglen; Saskatoon; Spruce Home; 35.4 km N of Stoughton; Swift Current and 80 km E of; Tessier; Torquay; Tunstall; Val Marie; Willow Bunch; 30 km NE of Zealandia.

Lygus lineolaris (Palisot de Beauvois)

Figs. 1, 2, 27-39

Capsus lineolaris Palisot de Beauvois, 1818: 187.
Capsus oblineatus Say, 1832: 21. Synonymized by Uhler, 1872: 413.
Lygus lineolaris: Uhler, 1872: 413; Kelton, 1955c: 552; 1975: 43; 1980: 118; Carvalho, 1959: 150; Henry and Wheeler, 1988: 323.
Capsus flavonotatus Provancher, 1872: 103. Synonymized by Van Duzee, 1912: 321.
Capsus strigulatus Walker, 1873: 94. Synonymized by Knight, 1921: 197.
Lygus pratensis var. *oblineatus*: Knight, 1917: 564.
Lygus pratensis var. *rubidus* Knight, 1917: 565. Synonymized by Kelton, 1975: 43.

Diagnosis of adults

The submedian stripe of the frons will distinguish *L. lineolaris* (Fig. 2) from almost all the other species of *Lygus* frequently encountered in agricultural situations in the Prairies. The submedian stripe may be very reduced but is always present at least as a darkened mark between the lateral stripe adjacent to the eye and the medial stripe. *Lygus lineolaris* is separated from species with submedian stripes (not usually found in agricultural situations) by the longer, denser vestiture (*L. rufidorsus* (Kelton) has very short and sparse vestiture and usually is slightly larger), the hemelytra without patchy vestiture (*L. plagiatus* Uhler has patches of silvery setae on the hemelytra and has a flattened general aspect), and red or yellow lateral margins of the mesoscutum (the mesoscutum of *L. unctuosus* (Kelton) is uniformly black).

Variation

Figures 1, 27-31. The overall coloration pattern is very variable, but the submedian stripe of the frons, the yellow or red lateral margins of the mesoscutum, and the pale cuneus with a black apex are always

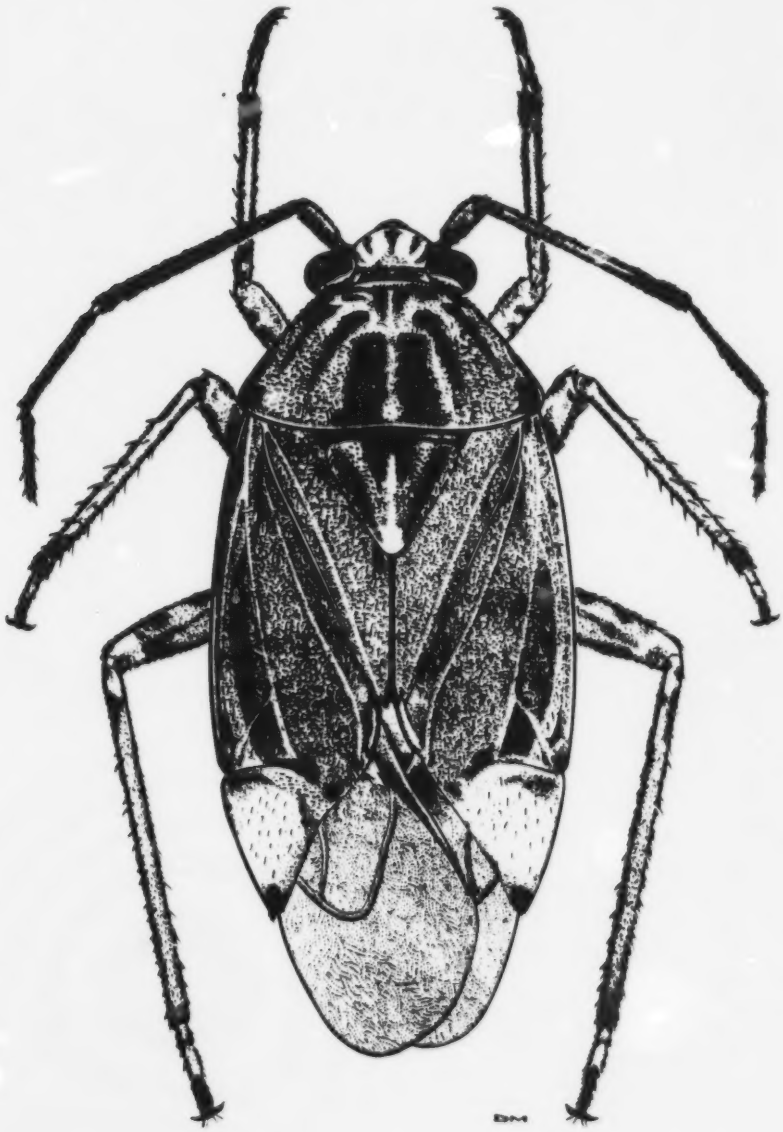
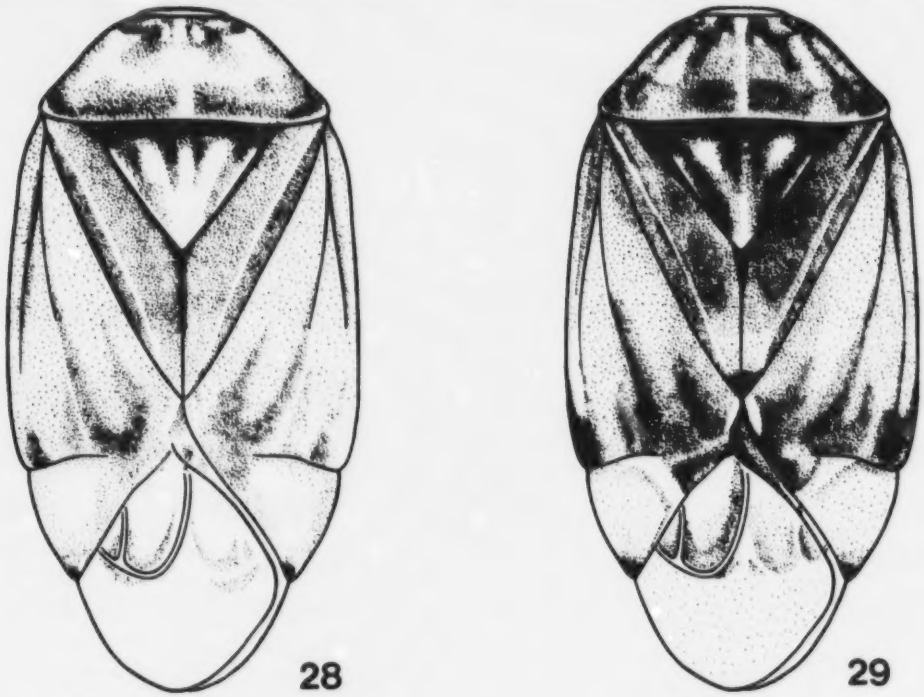
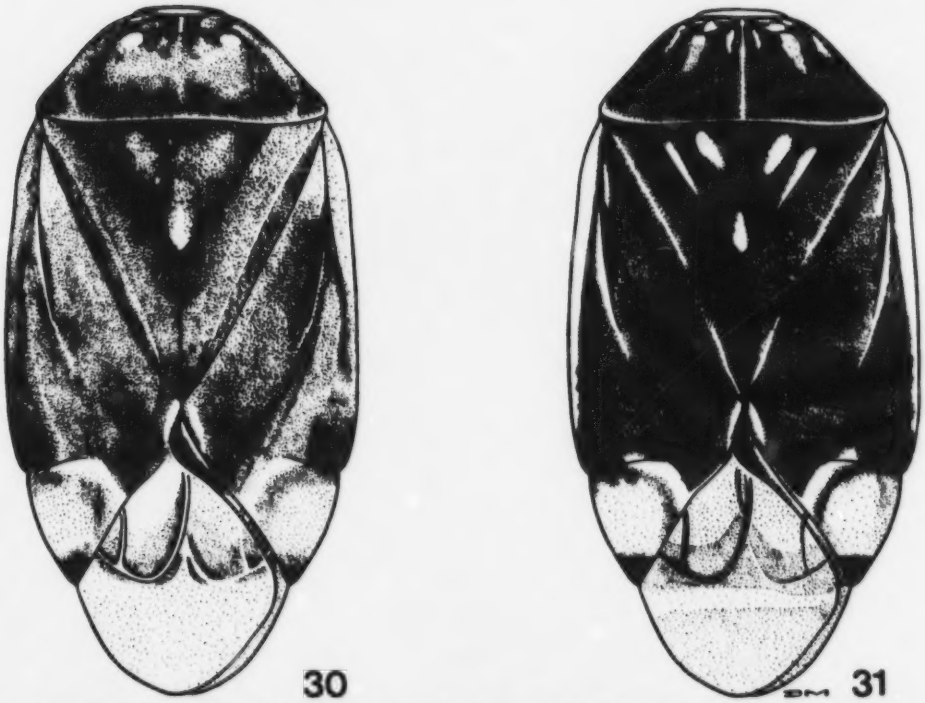


Fig. 27 *Lygus lineolaris* (Palisot de Beauvois), male dorsal habitus, Winnipeg, MB.





Figs. 28-31 *Lygus lineolaris* (Palisot de Beauvois), variation of dorsum. 28. nr. Iroquois Falls, ON. 29. nr. Portage la Prairie, MB. 30. Saskatoon, SK. 31. nr. Prawda, MB.

present. Within a population males are somewhat darker than females. The submedian stripe on the frons is sometimes broken or reduced to a single dorsal spot. Sometimes the median and lateral lines of the scutellum merge, forming a dark scutellum with three pale spots (two basal and one apical).

Overwintered generation The general coloration is yellow, orange, or red brown with a dull sheen. Overwintered specimens have the same range of variation as in summer specimens but, the contrast between pale and dark areas is diminished.

Summer generation(s) The general coloration ranges from pale yellow with a few black markings to almost completely black with a few pale yellow markings. The darkest specimens will retain pale markings on the following areas: lateral of the midline of the tylus and frons narrowly, lateral of the median stripe of the frons, medially on the lorum, posteriorly on the gula, vertex, antennal segment 2 subbasally, portions of labial segments 2 and 3 collar, lateral and posterior pronotal margins, midline of pronotum, anterior and posterior of the callus, two streaks posterior of the callus, lateral margins of mesoscutum (may have only a red or brown cast as compared to the middle), three spots on the scutellum, base and apex of the claval vein, anal ridge, base of the radius, base near paracuneus and interior of the cuneus, the propleuron adjacent to the procoxa and on a small median ridge, mesepisternum and mesepimeron adjacent to the mesocoxa, dorsal apex of mesepimeron, dorsal portion of the basalar plate, ostiolar peritreme, on abdominal sternites at spiracles and midline of sternites 2-6, trochanter, apex of the femur, middle of the tibia, and tarsal segments 1 and 2. Summer specimens have great contrast between pale and dark areas and are shiny regardless of the color pattern.

Diagnosis of nymphal stages

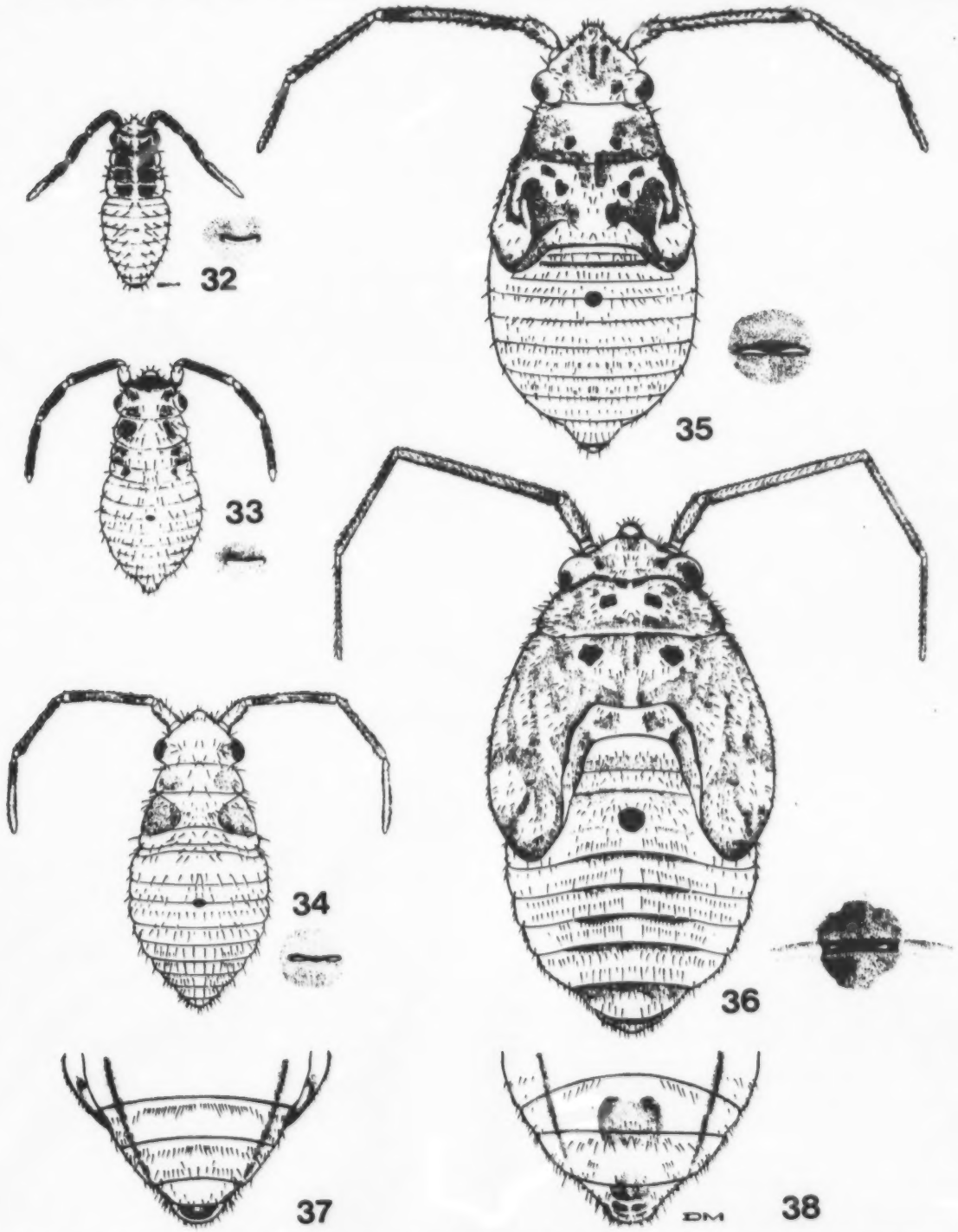
Recognized by the extensive and variable dark red, red brown or brown marking of instars 4 and 5; the submedian stripe on the frons and the marking on the dorsal and lateral aspects of the abdomen are especially diagnostic. Sometimes in instars 4 and 5 and usually in instars 1-3 the patterned markings are pale brown with the dark red or brown coloration lacking. In all instar stages *L. lineolaris* can be distinguished from *L. borealis* and *L. elisus* by the longer antennal segment 4. In instar 1 segment 4 of *L. lineolaris* is about equal to the combined length of segments 2 and 3; in *L. borealis* and *L. elisus* antennal segment 4 is about two-thirds longer than segment 2 or 3. In instar 2 of *L. lineolaris* segment 4 is three-fourths to four-fifths longer than antennal segment 2; in *L. borealis* and *L. elisus* segment 4 is about equal to segment 2. In *L. lineolaris* segment 4 of instar 3 is approximately four-fifths longer than segment 3, and equal to segment 2; in *L. borealis* and *L. elisus* segment 4 is equal to, or just longer than, antennal segment 3. In instar 4 segment 4 is equal to segment 3 in *L. lineolaris*, and shorter than segment 3 in *L. borealis* and *L. elisus*. The length of segment 4 in instar 5 is diagnostic in *L. lineolaris*; it ranges from 0.71-0.88 and in *L. borealis* and *L. elisus* it ranges from 0.57-0.70.

Description of nymphal stages

Instar 1 Figure 32. Maximum length 1.07-1.22; width of head across eyes 0.35-0.41. General coloration: yellow green; head yellow, eyes dark, all antennal segments dark except narrowly at base and apex; head and thorax with dark markings medially, dark areas bisected by pale median stripe, head also with pale 'V' shaped marking; femur and tibia darkly infuscate (tibia darkest basally), tarsus black; apex of labium black. Dorsal scent gland opening located medially between abdominal tergites 3 and 4, aperture ovoid, narrowly darkened. Length of antennal segments: 4 subequal to 2 and 3 combined, 3 subequal to 2; length 1, 0.11-0.13; 2, 0.22-0.27; 3, 0.20-0.24; 4 0.39-0.41. Vestiture: with rings of equal-length, brown primary setae. Length of labium 0.66-0.70, apex reaching from base to middle of abdomen. Length of metatibia 0.48-0.59.

Instar 2 Figure 33. Maximum length 1.65-1.80; width of head across eyes 0.45-0.52. General coloration as instar 1 except: dark markings on head and thorax bisected by wider, pale median stripe, head with pale star-shaped marking, antennal segment 1 dark basally. Thorax wider than instar 1. Length of antennal segments: 4 from three- fourths to four-fifths longer than 2, 3 subequal to both 2 and 4; length 1, 0.14-0.16; 2, 0.35-0.42; 3, 0.29-0.35; 4, 0.43-0.50. Vestiture: with rings of primary setae intermixed with shorter, secondary setae, midline of abdomen without setae. Length of labium 0.88-0.97, apex reaching base of abdomen. Length of metatibia 0.67-0.77.

Instar 3 Figure 34. Maximum length 2.09-2.47; width of head across eyes 0.62-0.69. General coloration as instar 2 except: head yellow, without dark markings, antennal segment 1 with dark markings



Figs. 32-38 *Lygus lineolaris* (Palisot de Beauvois), nymphal stages. 32-36. Dorsal habitus with detail of dorsal scent gland opening. 32. Instar 1. 33. Instar 2. 34. Instar 3. 35. Instar 4. 36. Instar 5. 37, 38. Sternite, ventral view. 37. Male. 38. Female.

ventrally; pronotum with round bilateral markings; developing mesothorax black laterally; older specimens with pair of black spots on pro- and mesothorax. Meso- and metathorax flattened and expanded posteriorly, forming wing pads that overlap base of abdomen. Dorsal scent gland opening within larger black spot, aperture overlapping in middle. Length of antennal segments: 4 just longer than 3, 4 subequal or equal to 2; length 1, 0.19-0.22; 2, 0.56-0.64; 3, 0.46-0.50; 4, 0.53-0.62. Vestiture: abdomen with rings primary and secondary setae, each abdominal segment with one ring, thorax also with scattered, short setae in addition to rings of setae. Length of labium 1.14-1.30, apex reaching base of abdomen. Length of metatibia 1.02-1.09.

Instar 4 Figure 35. Maximum length 2.05-3.36; width of head across eyes 0.76-0.86. General coloration: green; head and thorax with dark patterning, two pairs of thorax spots and spot broadly surrounding dorsal scent gland opening prominent and black; propleuron with dark mark. Wing pads reaching abdominal segment 3. Lateral margin of thorax straight, mesothorax overlapping but not obscuring metathorax. Length of antennal segments: 2 one-third longer than 3 or 4, 3 and 4 subequal; length 1, 0.27-0.31; 2, 0.81-0.96; 3, 0.65-0.74; 4, 0.64-0.71. Vestiture: abdomen with rings of various length setae, each segment with two rings, thorax with scattered, short setae. Length of labium 1.47-1.76, apex reaching base of abdomen. Length of metatibia 1.33-1.48.

Instar 5 Figure 36. Maximum length 3.42-4.95; width of head across eyes 0.92-1.07. General coloration: green; head, thorax, and abdomen with dark patterning, five black dorsal spots prominent; propleuron with dark mark. Wing pads reaching abdominal segment 5. Lateral margin of thorax convex, mesothorax overlapping and obscuring apex of metathorax. Length of antennal segments: 2 one-third longer than 3, 4 subequal to 3; length 1, 0.38-0.44; 2, 1.15-1.32; 3, 0.83-0.93; 4, 0.71-0.88. Vestiture: abdomen with rings of various length setae, each segment with two rings, thorax with scattered, short setae. Length of labium 1.82-2.16, apex reaching apex of metacoxa, or slightly beyond. Length of metatibia 1.92-2.05.

Discussion Crosby and Leonard (1914) described and illustrated instars 2-4 of *L. lineolaris* (not instars 1-3, as their figures 50-52 indicate).

Host plants

The "tarnished plant bug" is an extremely polyphagous insect having over 300 recorded hosts with 130 of these regarded as economically important plants (Young 1986). In the Prairie Provinces, *L. lineolaris* has been collected on: *Achillea millefolium*, *Ambrosia* sp., *Antennaria aprica*, *Artemisia frigida*, *Artemisia tridentata* Nutt., aster, *Betula nana* L. var. *sibirica* Led., *Brassica campestris*, *B. juncea*, *B. napus*, *Capsella bursa-pastoris*, caragana, *Chenopodium album*, *Fagopyrum esculentum* Moench, *Lupinus argenteus*, *Medicago sativa*, *Melilotus alba*, *Mentha arvensis* L., oats, *Picea glauca* (Moench) Voss, *Pinus banksiana* Lamb., *Polygonum* sp., *Populus tremuloides* Michx., *Prunus virginiana* L. var. *melanocarpa* (A. Nels.) Sarg., russian pigweed, (*Axyris amaranthoides* L.), *Quercus macrocarpa* Michx., *Salix* sp., sedge meadows, *Sinapis alba*, *Solidago* sp., *Symphoricarpos occidentalis*, *Thlaspi arvense* L., and *Trifolium* hybrid.

Distribution

The most widely distributed *Lygus* species in North America, *L. lineolaris* is found in all agricultural areas from low to relatively high elevations from east central Alaska southeast to Newfoundland and south to southern Mexico.

Prairie collections Figure 39. ALBERTA: Athabasca; Bassano; Bellis; Castor; Coal Valley; Coronado; Crowsnest Pass; Cypress Hills Prov. Park; Demmitt; Doussal; Drumheller and 3.8 km N of; Edmonton; Elk; Elkwater; Fairview; Grande Prairie; High Prairie; Jasper National Park; Kleskun Hill; Lac la Biche; Lethbridge; Lundbreck; Fort McMurray; Medicine Hat; Nevis; Nordegg; Onefour; Peace River; Red Deer; Rycroft; Stettler; Steveville; Sturgeon Lake; Valleyview; Vegreville; Wagner; Waterton Lakes National Park MANITOBA: Aweme; Beausejour; Boissevain; Brandon and 15 mi S of; Carberry and 10 km W of; Carman; Clandeboye; East Braintree; Elma; Falcon Lake; Faloma; 9 mi N of Forrest; Fort Garry; 2.5 km NW of and 5 km NW of Foxwarren; 3.4 km W of Gladstone; Harrowby; Hartney; Haywood; Horton; Husavik; Libau; Mafeking; Melita; Minnedosa; Moose Lake; Morris; Napinka; 3.0 km E of Neepawa; Ninette; 4.7 km E of Oak Lake; Oak Lake; Onah; Petersfield; Portage la Prairie; Prawda; Reynolds; Riding Mountain National Park; 10 mi W of and 30 mi N of Roblin; Roseau River; Russell and 6.4 km W of; St. Francois Xavier; St-Lazare; Selkirk; Shellmouth; 5

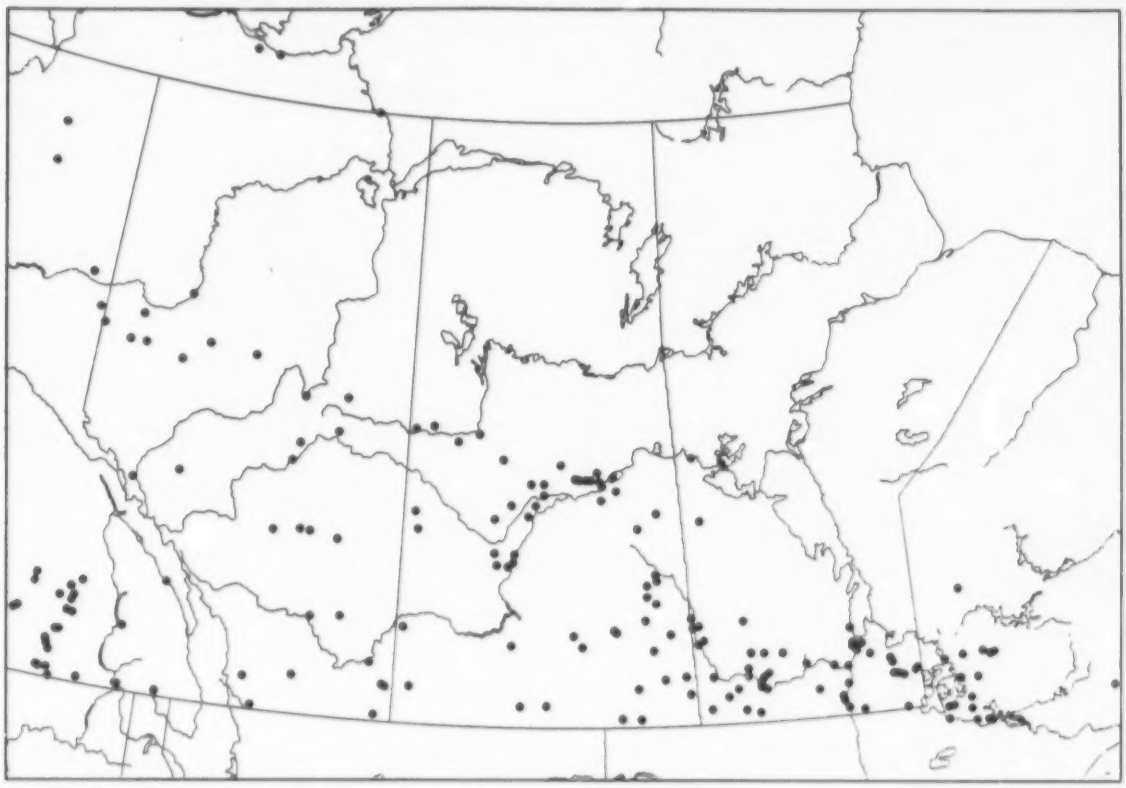


Fig. 39 Distribution of *Lygus lineolaris* (Palisot de Beauvois).

mi SW of Shilo; Shoal Lake; Souris; Sprague; Stockton and 2 mi W of; The Pas; Tolstoi and 4.7 km E of; Treesbank; Turtle Mountain; Virden and 5 km NW of; Whitemouth; Winnipeg. SASKATCHEWAN: Amsterdam; Angusville; Armley; Asquith; Beaver Creek; Big River; Broadview; Candle Lake; Canora; Carrot River; Chaplin; Christopher Lake; Choiceland; Cypress Hills Prov. Park; 3.5 km NE of Delisle; Duck Lake and 10 km S of; Esterhazy; Estevan; 7 km W of Fairlight; Frys; Garrick; Gascoigne; Goodsoil; Good Spirit Lake Prov. Park; Green Lake; 10 km SE of Hanley; Hudson Bay; Indian Head; Kenosee Lake; Katepwa Prov. Park; Leask; Lebret; Lumsden; Macdowall; Madge Lake; Meadow Lake; 5.0 km E of Melville; Neilburg; Nipawin and 14.2 km S of; Pas Trail; Pierceland; Pike Lake; Pipestone Creek; Prince Albert; Redberry; Rutland; Saskatoon and 62.0 km SW of; 10.7 km S of Smeaton; Snowden; Somme; Springside; Spruce Home; 35.4 km N of and 45.8 km N of Stoughton; Torch River; Torquay; Waskesiu Lake; White Fox; Willow Bunch; Wood Mountain; Yorkton.

Lygus rubrosignatus Knight

Figs. 40, 41

Lygus pratensis var. *rubrosignatus* Knight, 1923: 576.
Lygus rubrosignatus: Knight, 1953: 518; Carvalho, 1959: 155; Kelton, 1975: 41; 1980: 133; Henry and Wheeler, 1988: 326.
Liocoris rubrosignatus: Kelton, 1955c: 550.

Diagnosis of adults

The pale to yellow green summer adults of *L. rubrosignatus* are separated from *L. borealis* by the long, dense dorsal vestiture (Fig. 40) and from *L. elisus* by the anterior angles of the pronotum, that are produced in lateral view, and usually prominent in dorsal view (in *L. elisus* the angles are rounded in both lateral and dorsal views). Red overwintered adults are distinguished from *L. shulli* by the shorter antennal

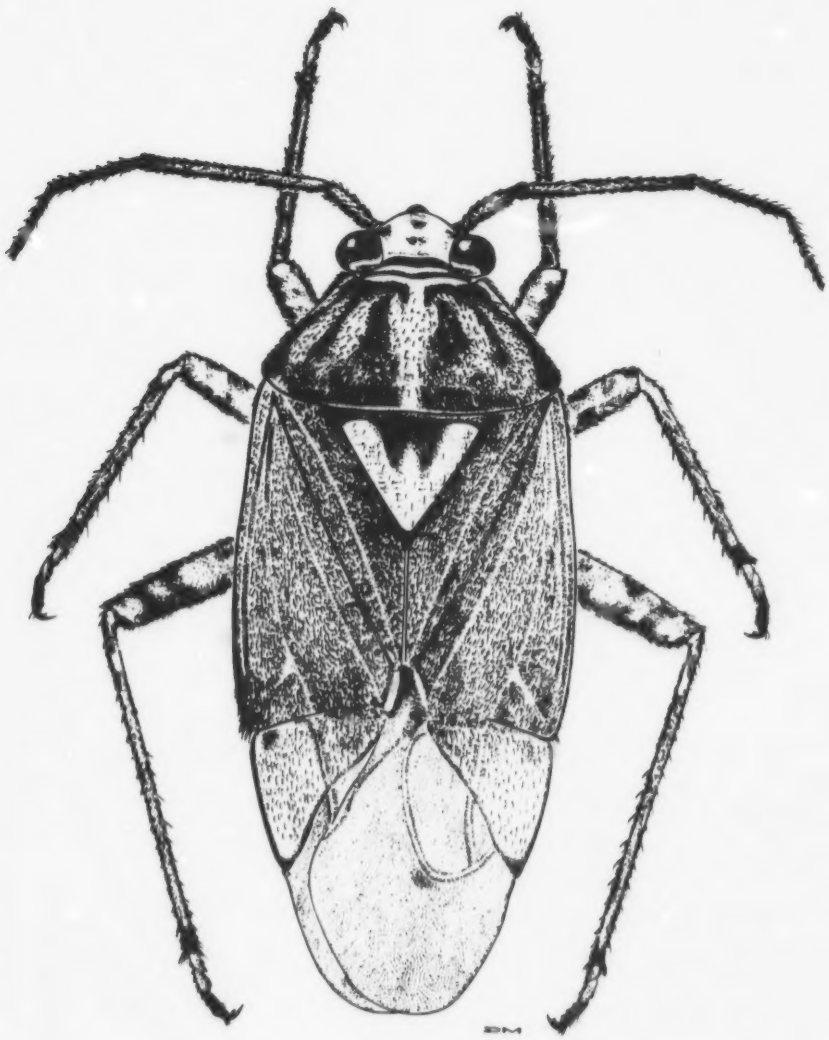


Fig. 40 *Lygus rubrosignatus* Knight, male dorsal habitus, 10 km S of Duck Lake, SK.

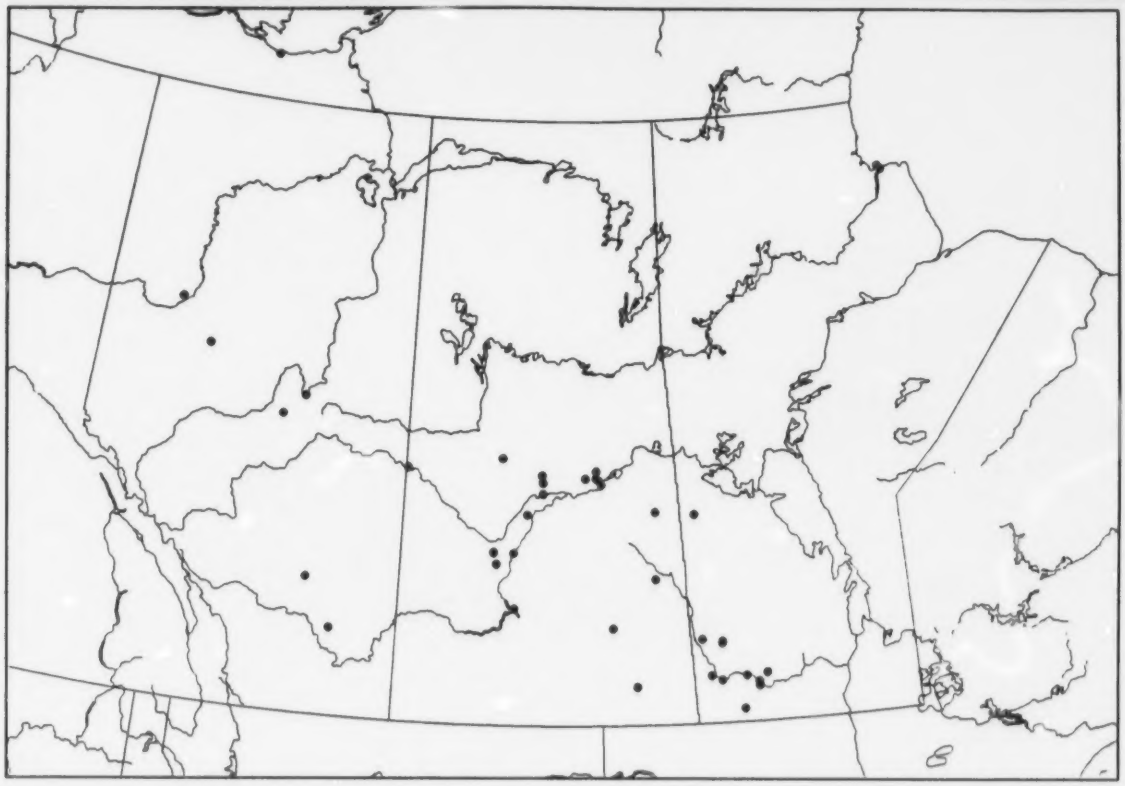


Fig. 41 Distribution of *Lygus rubrosignatus* Knight.

segment 2, the more flattened conformation of the pronotum, and the long, dense vestiture. This species is usually distinguished from *L. solidaginis* by the absence of lateral lines on the scutellum, the absence of a red triangular mark on the corium, the prominent anterior angles of the more shallowly, punctate pronotum, and the shorter antennal segment 2.

Variation

The prominent anterior angles of the pronotum in dorsal view, is present in a majority of specimens from any given series. Both seasonal generations are usually strongly marked with red, brown, or black on both dorsal and ventral aspects; the darkest specimen will have yellow markings on the frons, vertex, collar, anterior of the callus, rays on the pronotum posterior to the callus, and scutellum.

Overwintered generation Generally with darker coloration than the summer generation.

Summer generation(s) Usually with more yellow or yellow green coloration then the overwintered generation. Sometimes the pronotum is mottled with brown. The apex of the tibia is usually red; sometimes the apex may be slightly tinged with red or brown.

Host plants

Kelton (1975) reports this species breeding on *Senecio palustris* (L.) Hook. and casual records on alfalfa, *Artemisia* sp., bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.), ox-eye daisy (*Chrysanthemum leucanthemum* L.), jackpine (*Pinus banksiana*), and rose. Specimens were collected on fireweed (*Epilobium angustifolium*) from Takhini Hot Springs, Yukon. Schwartz and Foottit (1992) collected small numbers of *L. rubrosignatus* on commercial fields of *Brassica campestris*, *B. juncea*, *B. napus*, Medicago sativa, *Melilotus alba*, *Mentha spicata* L., and *Sinapis alba*. On the east coast, *Lechea* spp. (Cistaceae) are host plants of this species (T. J. Henry pers. comm.).

Distribution

This species, as well as *L. borealis*, *L. columbiensis* Knight, *L. potentillae* Kelton, *L. ravus* Stanger, *L. rubroclarus* Knight, *L. rufidorsus*, *L. unctuosus*, and *L. varius* Knight, have boreal distributions. Typically the ranges of these species extend from southcentral Alaska southeast to the Northwest Territories (southwest of the Mackenzie River), further southeast to near Churchill, Manitoba, and the Great Whale River, Québec, to southeastern Labrabor and Newfoundland. All of these species, except *L. rubrosignatus*, have ranges that extend south of the Canadian border into the Rocky Mountains. Its range also differs from the other species of *Lygus* with mostly boreal distributions, by having a large range disjunction. The western populations are separated from sporadically distributed populations in the coastal northeastern United States and Newfoundland.

Prairie collections Figure 41. ALBERTA: Athabasca; Brooks, ex *Mentha spicata*; Dapp, ex sage; Doussal, ex *Senecio palustris*; Drumheller and 3.8 km N of, ex *Brassica napus*, *Sinapis alba*; Fort McMurray; Grimshaw; High Prairie. MANITOBA: Aweme; Baden; Boissevain; Brandon; Carberry; Churchill; 5 km NW of Foxwarren, ex *B. napus*; 4.7 km E of Oak Lake, ex *Medicago sativa*, *Melilotus alba*; 5 mi SW of Shilo; 7 km SE of Shoal Lake, ex *B. napus*; Treesbank; 5 km NW of Virden, ex *B. napus* (HC 120, hybrid canola). SASKATCHEWAN: Asquith; Big River; Canora; Choiceland, ex *B.napus*; Christopher Lake; 3.5 km of Delisle, ex *B. napus*; 10 km S of Duck Lake, ex *B. campestris*; Elbow; Harlan; Hudson Bay; Kenosee Lake, ex *Senecio palustris*; Lebret; Love, ex *Medicago sativa*; Macdowall, ex *B. napus*; Nipawin; Prince Albert, ex *Pinus banksiana*, and 7 km N of, ex *Medicago sativa*, *Melilotus alba*; Saskatoon, ex *B. campestris*, and 62.0 km SW of, ex *B. napus*; Spruce Home, ex *B. campestris*, *B. juncea*, and *B. napus*; 35.4 km N of Stoughton, ex *B. juncea*; Swift River; Torch River, ex *Medicago sativa* and bearberry; White Fox, ex *M. sativa*; 30 km NE of Zealandia, ex *B. juncea*.

Lygus shulli Knight

Figs. 42, 43

Lygus shulli Knight, 1941b: 272; Carvalho, 1959: 156; Kelton, 1975: 35; 1980: 131; Henry and Wheeler, 1988: 326.

Liocoris shulli: Kelton, 1955c: 552.

Diagnosis of adults

This species has sparse and short dorsal vestiture (Fig. 42) and a strongly convex pronotum in comparison with *L. rubrosignatus* and *L. solidaginis*, the two other large and darkly colored *Lygus* species encountered in agricultural situations in the Prairies. *Lygus shulli* has vestiture similar to *L. borealis*, but is distinguished by the longer antennal segment 2 and labium, the black-tipped cuneus, and the robust, convex general conformation. In addition to the longer antennal segment 2 and labium, the produced anterior angles of the pronotum, in lateral view, and dark mark on the propleuron will separate *L. shulli* from *L. elisus*.

Variation

Females with less extensive red brown or black markings than males (including the palest males of any population). Overwintered generation with more extensive dark markings than summer generation(s). Overwintered specimens, regardless of the extent of dark markings, always lack dark lateral scutellar lines; sometimes the lateral line area has a slight red shading in the darkest specimens. The middle of antennal segment 2 is always paler than the red brown or black apical and basal portions of the segment. Seasonal color darkening is evident in late summer and fall.

Overwintered generation Opaque, dull or pale general luster with variable pattern of dark red or red brown markings on dorsal and ventral aspect. Pale yellow coloration is maintained on the middle of antennal segment 2 (sometimes just slightly so), and the middle of the frons, the lateral margin of the scutellum, the apex of the clavus, the cuneus, and the ostiolar peritreme. The palest overwintered specimen always has more extensive dark markings (on the body regions described for the Summer generation(s)) than early summer specimens. The pattern of seasonal color darkening displays a tendency for the pale brown areas to expand across the hemelytra and venter, deepening in intensity to dark red brown finally merging with the black regions. The ventral aspect is always darkened on the lateral margin and middle of the abdomen. The female retains more yellow, sometimes these areas have a green cast or markings.

Summer generation(s) General shining luster. Extensively pale yellow on the frons, the pronotum anterior of the callus, the scutellum, the paracuneus adjacent to the anal ridge, the cuneus, and the sternum. Ventral aspect with yellow green abdomen. Black markings on the ventral half of antennal segment 1, the

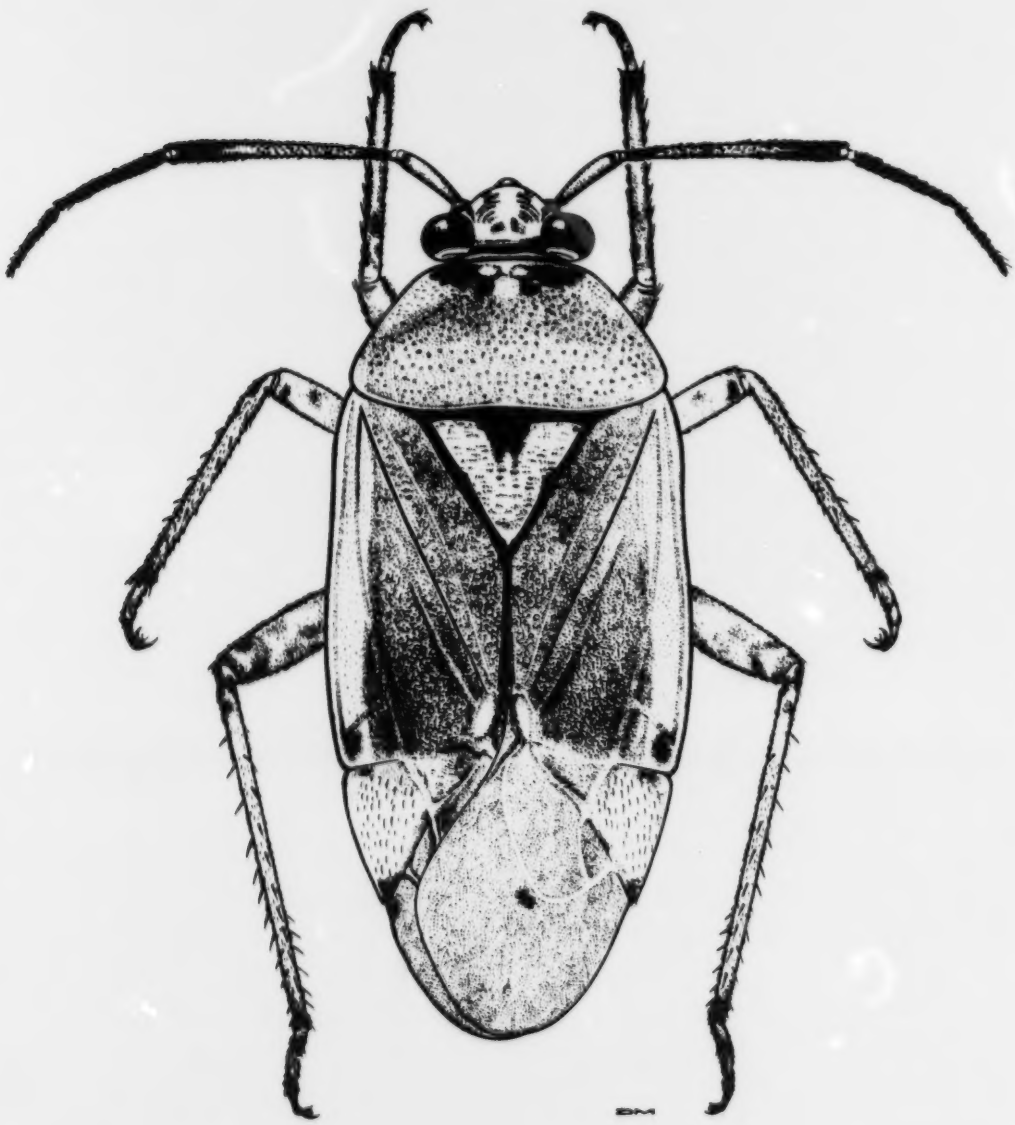


Fig. 42 *Lygus shulli* Knight, male dorsal habitus, 3.8 km N of Drumheller, AB.

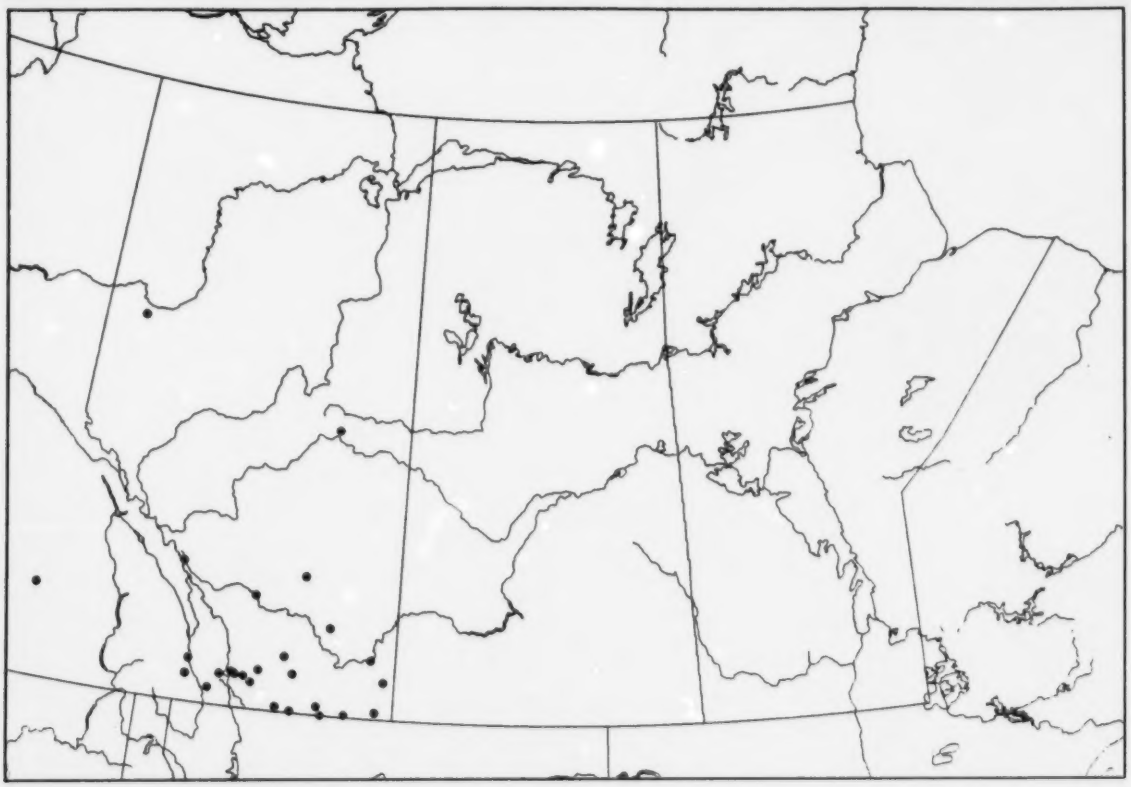


Fig. 43 Distribution of *Lygus shulli* Knight.

basal and apical one fourth of segment 2, segments 3 and 4, labial segment 4, the sutures separating the lorum from the bucculum and the jugum, a short line dorsal to the antennal insertion, the collum, the propleuron ventral to the anterior angles of the pronotum, three spots lateral to, and posterior to the callus, the mesoscutum, two median lines on the scutellum, and narrowly on the embolium, and base and apex of the cuneus. Brown shading interiorly of the apex of the costal vein, at the apical half of the radius, the apex and the middle of the clavus interior to claval vein. Leg concolorous with pale body with brown striping at the apex of the femur and base of the tibia. The palest females retain black markings on the antenna, the labium, on the two most medial spots posterior to the callus, the mesoscutum and the base of the scutellum medially, and the embolial margin.

Diagnosis of nymphal stages

The wider head width and longer length of the metatibia and antennal segment 2 will distinguish instars 3-5 of *L. shulli* from those of *L. borealis*, *L. elisus* and *L. lineolaris*. The unicolorous dark red coloration of the antenna will further distinguish *L. shulli*; the antenna of *L. borealis* is either unicolorous brown or infuscate brown and segment 2 of *L. elisus* is bicolorous with the middle one-third pale. The mostly pale, unpatterned head and abdomen of *L. shulli* will also distinguish it from *L. lineolaris*.

Description of nymphal stages

Instar 3 Maximum length 2.01-2.21. Width of head across eyes 0.77-0.78. Length of antennal segments: 1, 0.22-0.26; 2, 0.71-0.77; 3, 0.49-0.55; 4, 0.50-0.56. Length of labium 1.27-1.40. Length of metatibia 1.08-1.19. General coloration pale yellow or green with typical dark spots two pairs on thorax dorsally, one surrounding dorsal scent gland aperture, and on knee of tibia; antenna unicolorous dark red; tibia mostly infuscate brown with apex and knee dark, knee and infuscate area separated by pale space.

Instar 4 Maximum length 2.59-3.26. Width of head across eyes 0.95-1.01. Length of antennal segments: 1, 0.30-0.35; 2, 1.00-1.17; 3, 0.64-0.79; 4, 0.57-0.65. Length of labium 1.69-1.81. Length of metatibia 1.55-1.69. General coloration as instar 3 except: dark spot on propleura; if tibia not infuscate than basal edge of former infuscate area dark brown, forming subbasal ring. Dorsal patterning of body brown.

Instar 5 Maximum length 4.02. Width of head across eyes 1.14-1.16. Length of antennal segments: 1, 0.45-0.47; 2, 1.53-1.57; 3, 0.90-0.92; 4, 0.63-0.67. Length of labium 2.13-2.14. Length of metatibia 2.23-2.36. General coloration as instar 4.

Host plants

Feeds on a wide variety of host plants: alfalfa, *Artemisia cana* Pursh, *Cynoglossum boreale* Fern., *Lupinus argenteus*, *Pinus banksiana*, *Potentilla* sp., *Rumex venosus* Pursh, *Salix* sp., *Solidago* sp., and *Verbascum thapsus*. Schwartz and Foottit (1992) collected small numbers of *L. shulli* on commercial fields of *Brassica campestris*, *B. juncea*, *B. napus*, *Mentha spicata*, and *Sinapis alba*.

Distribution

Widely distributed in western North America, apparently confined to agricultural areas and subalpine coniferous regions.

Prairie collections Figure 43. ALBERTA: Aden, Gilchrist Ranch ex alfalfa, crested wheat grass; Banff National Park; Barons, ex *Brassica napus*; Bassano, ex *B. napus*; Bellis, ex *Pinus banksiana*; Brooks, ex *Mentha spicata*; Calgary; Coleman; Coutts; Cowley ex *Cynoglossum boreale*; Crowsnest Pass, ex *Potentilla* sp.; Del Bonita; Doussal; Drumheller: 3.8 km N of, ex *B. napus*, *Sinapis alba*, 3.8 km S of, ex *B. napus*, and W of, ex *Artemisia cana*; Elkwater, ex aster, *Lupinus argenteus*, *Pinus banksiana*, *Salix* sp.; Fisher Creek A.F.S.; Frank, ex alfalfa; Kananaskis; Kimball; Lethbridge, ex alfalfa, *B. campestris*, *B. juncea*, and *B. napus*; Lundbreck, ex aster, *Verbascum thapsus*; Medicine Hat, ex alfalfa; Milk River, ex *Rumex venosus*, *Solidago* sp.; Nordegg; Onefour, ex alfalfa; Pincher Creek; Rycroft; Spring Point; Waterton Lakes National Park, ex range grass.

Lygus solidaginis (Kelton)

Figs. 44, 45

Liocoris solidaginis Kelton, 1955b: 489; 1955c: 554.

Lygus solidaginis: Carvalho, 1959: 156; Kelton, 1975: 55; 1980: 133; Henry and Wheeler, 1988: 326.

Diagnosis of adults

This species is distinguished from *L. shulli* and *L. rubrosignatus* (the two other larger and more darkly colored *Lygus* species encountered in agricultural situations) by the red brown to black triangular pattern of the corium, the deeply and closely punctate pronotum, and the lateral lines of the scutellum.

Variation

Red coloration is common on the head, scutellum, cuneus, and veins of the membrane.

Overwintered generation Sometimes the dark triangular pattern on the apical portion of the corium is difficult to discern on the darkest overwintered specimens (Fig. 44). Such dark specimens are red brown with black markings surrounding the callus, rays posterior of the callus, the basal angles and the posterior margin of the pronotum, mesoscutum, obscurely on the median line of the scutellum, and anteromedian mark of the propleuron. Pale markings are limited to vertex, collar, anterior of the callus, apex of the scutellum, and the anal ridge.

Summer generation(s) The dark triangular pattern on the apical portion of the corium is clearly present. Pale-colored specimens have brown markings on antennal segments three and four, the propleuron, sometimes laterally ringing the callus, three spots posteriorly of the callus, the posterior angles of the pronotum, mesoscutum, median lines of the scutellum, and tarsal segment three.

Host plants

Kelton (1955b, 1955c, 1975) reports overwintering adults of this species feeding and ovipositing on western snowberry (*Symphoricarpos occidentalis*) in early summer. Summer generation and overwintered adults move to goldenrod (*Solidago* spp.) in the late summer and fall. Causal collection records are from aster, baby's breath (*Gypsophila paniculata*), bearberry, Canada thistle (*Cirsium arvense*), *Caragana arborescens* Lam., hound's tongue (*Cynoglossum boreale*), *Juniperus communis* L., lamb's-quarters (*Chenopodium album*), low everlasting (*Antennaria aprica*), "pigweed," potato, silver buffaloberry (*Shepherdia argentea* Nutt.). Schwartz and Foottit (1992) collected small numbers

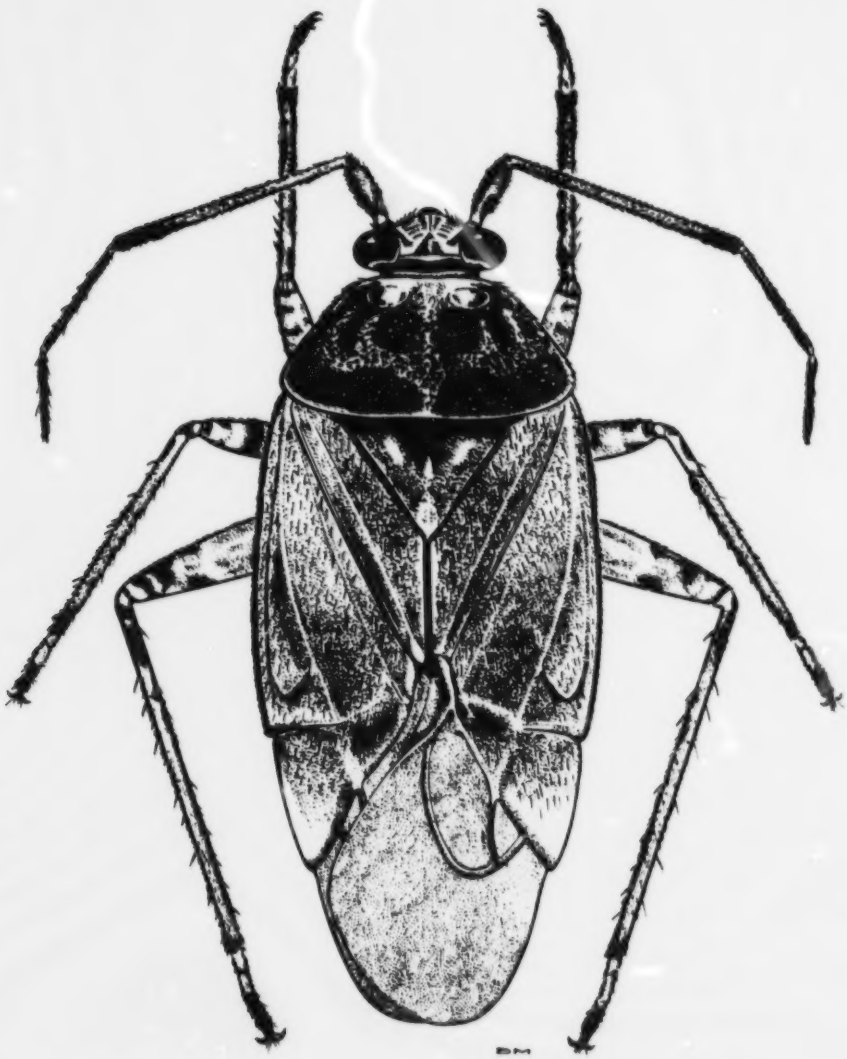


Fig. 44 *Lygus solidaginsis* Knight, male dorsal habitus, Brooks, AB.

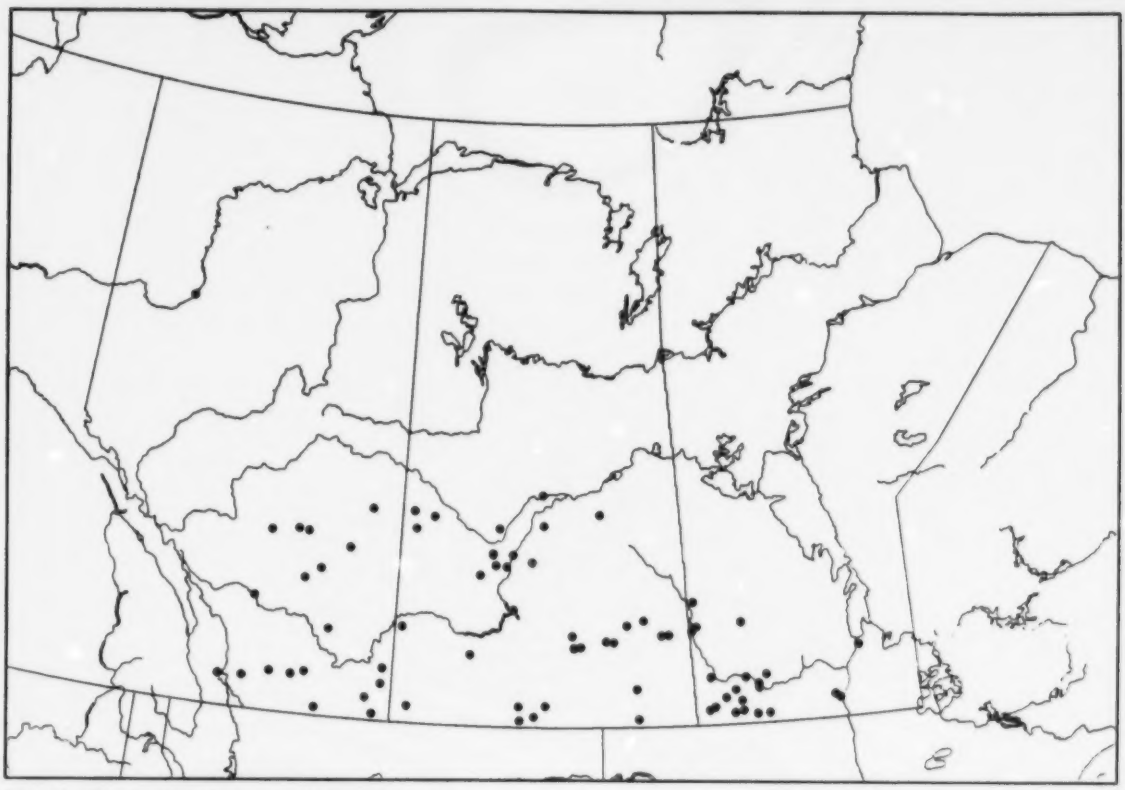


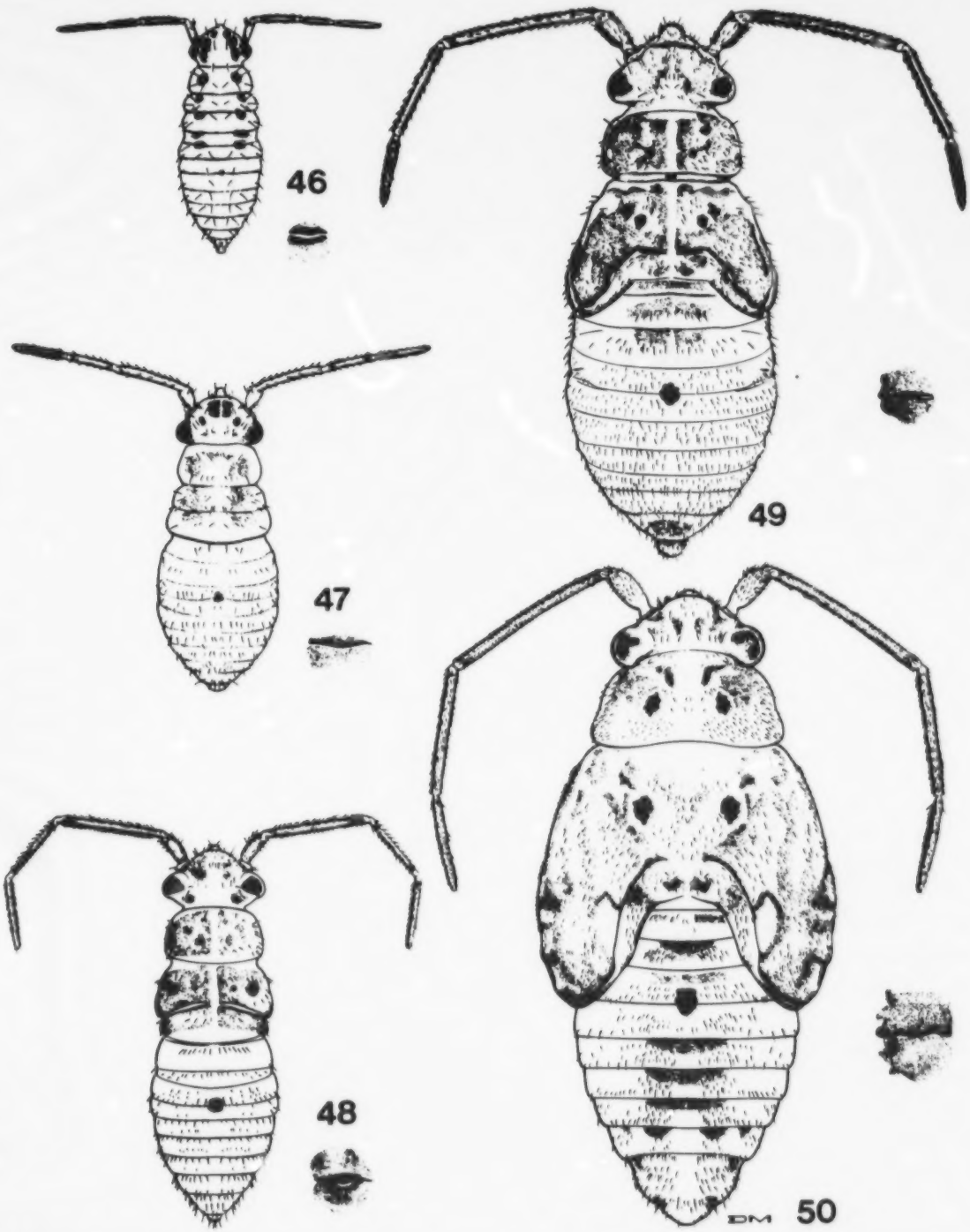
Fig. 45 Distribution of *Lygus solidagnisis* Knight.

of *L. solidaginis* on commercial fields of *Brassica campestris*, *B. juncea*, *B. napus*, *Mentha spicata*, and *Sinapis alba*, and on *S. arvensis*.

Distribution

The northernmost limit of this species is the Peace River region of Alberta and adjacent British Columbia; the northern prairies of Nebraska, Iowa, and Minnesota appear to mark its southern boundary. The majority of the collections are confined to the prairie and parkland regions of central Canada.

Prairie collections Figure 45. ALBERTA: Brooks, ex *Mentha spicata* and 14.3 km SE of, ex *Brassica napus*; Calgary; Chin; Coronation; Cowley; Craigmyle, ex *B. napus*; Drumheller: 3.8 km N of, ex *B. napus*, *Sinapis alba* and 3.8 km S of, ex *B. napus*; Elkwater, ex aster, *Symphoricarpos occidentalis*; Fort Macleod; Irvine; Lethbridge; Lundbreck; Manyberries; Milk River; Nevis; Onefour; Peace River; Red Deer; Stettler; Wainwright. MANITOBA: Aweme; Boissevain; Brandon; Carberry; Hartney; Horton; Libau; Melita; Millwood; Morris; Napinka; Riding Mountain National Park; 10 mi W of Roblin; Russell; Souris; Treesbank; Turtle Mountain; Virden; Whitewater. SASKATCHEWAN: Asquith, ex *S. occidentalis*; Consul, ex alfalfa; Cut Knife, Attons Lake; 3.5 km NE of Delisle, ex *B. napus*; Elbow; Elstow; Esterhazy; Estevan; Gascoigne; 8 km W of Grand Coulee, ex *Sinapis arvensis*; Great Deer, ex *Symphoricarpos occidentalis*; Great Sand Hills, 60 km W of Swift Current; Great Sand Hills; 10 km SE of Hanley, ex *B. juncea*; Harris, ex *Gyposphila paniculata*; Indian Head; Katepwa; Killdeer; Lorlie; Lumsden; 5.0 km E of Melville, ex *B. napus*; Neilburg; Pike Lake, ex alfalfa, *S. occidentalis*; Prince Albert, ex alfalfa; Qu'Appelle, ex *Sinapis alba*; Rockglen; Rutland; St. Victor; Saskatoon, ex bearberry, caragana, *Chenopodium album*, *Juniperus communis*, *Shepherdia argentea*, *Solidago* sp., and *Symphoricarpos occidentalis*, and 62.0 km SW of, ex *B. napus*; NE Saskatoon, ex *B. campestris*; Stockholm; Stoughton: 35.4 km N of, ex *B. juncea* and 45.8 km N



Figs. 46-50 *Lygus hesperus* Knight, nymphal stages, dorsal habitus with detail of dorsal scent gland opening. 46. Instar 1. 47. Instar 2. 48. Instar 3. 49. Instar 4. 50. Instar 5.

of, ex *Antennaria aprica*; Swift Current; Tisdale; Wakaw; Waskesiu Lake; Willow Bunch; Wood Mountain; 30 km NE of Zealandia, ex *B. juncea*.

Lygus hesperus Knight
Figs. 46-50

Lygus (Lygus) elisus var. *hesperus* Knight, 1917: 575.
Lygus hesperus: Shull 1933b: 1076; Carvalho, 1959: 149; Kelton, 1975: 33; Henry and Wheeler, 1988: 323.
Liocoris hesperus: Kelton, 1955c: 550.

Diagnosis of nymphal stages

A combination of coloration and antennal measurement will distinguish *L. hesperus* from *L. borealis*, *L. elisus*, *L. lineolaris*, and *L. shulli*. The longer length of antennal segment 2 will separate all instars of *L. hesperus* from *L. borealis* and *L. elisus*. Instars 3-5 of these species can be further distinguished by the coloration of segment 2; in *L. hesperus* segment 2 is unicolorous dark red, in *L. elisus* it is bicolorous red and pale, and in *L. borealis* it is unicolorous brown. The shorter length of antennal segment 4 in all instars and the absence of the submedian stripe on the frons in instars 4 and 5 will distinguish *L. hesperus* from *L. lineolaris*. The red marks on the femur, head, thorax laterally, and abdomen will distinguish instars 4 and 5 of *L. hesperus* from *L. shulli*. Generally the instars of *L. hesperus* are more elongate than the other species examined.

Description of nymphal Stages

Instar 1 Figure 46. Maximum length 1.29-1.50. Width of head across eyes 0.38-0.43. Length of antennal segments: 1, 0.09-0.13; 2, 0.27-0.31; 3, 0.23-0.26; 4, 0.34-0.38. Length of labium 0.72-0.77. Length of metatibia 0.51-0.56. General coloration pale yellow; pale brown on antennal segments, legs, and thorax dorsally.

Instar 2 Figure 47. Maximum length 1.85-1.94. Width of head across eyes 0.51-0.52. Length of antennal segments: 1, 0.13-0.15; 2, 0.43-0.47; 3, 0.33-0.36; 4, 0.40-0.44. Length of labium 0.93-0.98. Length of metatibia 0.68-0.76. General coloration as instar 1 except antennal segment 4 red.

Instar 3 Figure 48. Maximum length 2.01-2.57. Width of head across eyes 0.65-0.67. Length of antennal segments: 1, 0.16-0.22; 2, 0.67-0.79; 3, 0.50-0.56; 4, 0.43-0.52. Length of labium 1.22-1.43. Length of metatibia 1.00-1.06. General coloration as instar 2 except with dark spots two pairs on thorax dorsally, one surrounding dorsal scent gland aperture, and on knee of tibia; antennal segments 4, 3, and apical on-third of 2 red, segment 1 and remainder of 2 brown; femur with two apical brown bands, tibia faintly infuscate brown with apex and knee darker, knee and infuscate area separated by pale space.

Instar 4 Figure 49. Maximum length 2.71-3.36. Width of head across eyes 0.78-0.89. Length of antennal segments: 1, 0.26-0.33; 2, 0.95-1.17; 3, 0.64-0.76; 4, 0.52-0.58. Length of labium 1.67-1.83. Length of metatibia 1.34-1.52. General coloration as instar 3 except all antennal segments red, basal two-third of segment 2 sometimes infuscate brown; small dark brown spot on propleura; bright red on femur, head, thorax laterally, and abdomen; brown patterning on thorax and wing pads dorsally.

Instar 5 Figure 50. Maximum length 3.15-4.53. Width of head across eyes 0.99-1.12. Length of antennal segments: 1, 0.39-0.46; 2, 1.35-1.62; 3, 0.80-0.99; 4, 0.58-0.66. Length of labium 2.07-2.21. Length of metatibia 2.04-2.25. General coloration as instar 4.

Discussion

Lygus hesperus is not known to occur in the Prairie Provinces but is widespread in western North America where it is found abundantly in agricultural areas and at low altitude in the Rocky Mountains (Kelton 1975). We have included descriptive information on the instars of this species to help distinguish them from instars of *L. elisus* and *L. lineolaris* in areas of sympatry beyond the geographical coverage of this bulletin.

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Table 1 Measurements (mm) of *Lygus* Immatures[a]

	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5
Body Length					
L. borealis	1.02-1.24 (1.14±0.02)	1.34-1.68 (1.53±0.07)	1.80-2.55 (2.05±0.07)	2.03-3.14 (2.70±0.12)	2.98-4.45 (3.83±0.15)
L. elisus D[b]	0.91-1.41 (1.21±0.05)	1.43-1.65 (1.53±0.03)	1.55-2.24 (2.00±0.05)	2.29-2.66 (2.48±0.04)	2.72-3.88 (3.21±0.12)
L. elisus L	1.03-1.33 (1.20±0.05)	1.34-1.74 (1.53±0.06)	1.49-2.05 (1.81±0.08)	2.47-2.77 (2.61±0.04)	3.38-3.70 (3.53±0.07)
L. lineolaris	1.07-1.22 (1.23±0.04)	1.65-1.80 (1.75±0.03)	2.09-2.47 (2.27±0.04)	2.05-3.36 (3.09±0.09)	3.42-4.95 (4.16±0.13)
L. hesperus	1.29-1.50 (1.42±0.03)	1.85-1.94 (1.88±0.03)	2.01-2.57 (2.34±0.08)	2.71-3.36 (2.80±0.29)	3.15-4.53 (4.03±0.19)
L. shulli	—	—	2.01-2.21 (2.11±0.04)	2.59-3.26 (2.88±0.11)	4.02 (4.02±0.00)
Head Width					
L. borealis	0.36-0.43 (0.39±0.01)	0.49-0.55 (0.52±0.01)	0.64-0.72 (0.69±0.01)	0.80-0.89 (0.86±0.01)	0.99-1.11 (1.05±0.01)
L. elisus D	0.37-0.42 (0.39±0.01)	0.47-0.52 (0.50±0.00)	0.61-0.67 (0.64±0.00)	0.74-0.84 (0.80±0.01)	0.93-1.02 (0.98±0.01)
L. elisus L	0.35-0.38 (0.37±0.00)	0.50-0.53 (0.52±0.00)	0.62-0.68 (0.66±0.01)	0.79-0.88 (0.86±0.02)	1.02-1.09 (1.06±0.01)
L. lineolaris	0.35-0.41 (0.39±0.01)	0.45-0.52 (0.48±0.01)	0.62-0.69 (0.66±0.01)	0.76-0.86 (0.82±0.01)	0.92-1.07 (1.00±0.01)
L. hesperus	0.38-0.43 (0.41±0.00)	0.51-0.52 (0.52±0.03)	0.65-0.67 (0.66±0.00)	0.78-0.89 (0.84±0.01)	0.99-1.12 (1.06±0.01)
L. shulli	—	—	0.77-0.78 (0.77±0.00)	0.95-1.01 (0.97±0.01)	1.14-1.16 (1.15±0.01)
Antennal Segment 1 Length					
L. borealis	0.10-0.13 (0.11±0.00)	0.12-0.18 (0.15±0.01)	0.19-0.23 (0.21±0.00)	0.25-0.30 (0.28±0.00)	0.34-0.41 (0.38±0.00)
L. elisus D	0.09-0.13 (0.11±0.00)	0.12-0.15 (0.13±0.00)	0.17-0.21 (0.19±0.00)	0.24-0.29 (0.26±0.00)	0.32-0.38 (0.35±0.00)
L. elisus L	0.09-0.13 (0.11±0.00)	0.12-0.16 (0.14±0.00)	0.15-0.19 (0.17±0.00)	0.23-0.28 (0.26±0.01)	0.33-0.39 (0.36±0.01)
L. lineolaris	0.11-0.13 (0.12±0.00)	0.14-0.16 (0.15±0.00)	0.19-0.22 (0.21±0.00)	0.27-0.31 (0.29±0.00)	0.38-0.44 (0.41±0.00)
L. hesperus	0.09-0.13 (0.11±0.00)	0.13-0.15 (0.14±0.00)	0.16-0.22 (0.20±0.00)	0.26-0.33 (0.29±0.01)	0.39-0.46 (0.41±0.01)
L. shulli	—	—	0.22-0.26 (0.25±0.01)	0.30-0.35 (0.33±0.00)	0.45-0.47 (0.46±0.01)
Antennal Segment 2 Length					
L. borealis	0.24-0.28 (0.27±0.00)	0.39-0.43 (0.40±0.01)	0.56-0.66 (0.61±0.01)	0.83-0.92 (0.89±0.00)	1.12-1.28 (1.20±0.01)
L. elisus D	0.24-0.30 (0.28±0.00)	0.37-0.44 (0.41±0.00)	0.58-0.69 (0.66±0.00)	0.83-0.99 (0.92±0.01)	1.10-1.34 (1.25±0.02)
L. elisus L	0.21-0.27 (0.24±0.00)	0.35-0.40 (0.37±0.00)	0.51-0.59 (0.55±0.01)	0.81-0.93 (0.87±0.02)	1.24-1.39 (1.31±0.03)
L. lineolaris	0.22-0.27 (0.25±0.00)	0.35-0.42 (0.37±0.00)	0.56-0.64 (0.60±0.00)	0.81-0.96 (0.90±0.01)	1.15-1.32 (1.24±0.01)
L. hesperus	0.27-0.31 (0.30±0.00)	0.43-0.47 (0.45±0.01)	0.67-0.79 (0.72±0.01)	0.95-1.17 (1.07±0.01)	1.35-1.62 (1.52±0.02)
L. shulli	—	—	0.71-0.77 (0.74±0.01)	1.00-1.17 (1.10±0.02)	1.53-1.57 (1.55±0.01)

(continued)

Table 1 Measurements (mm) of *Lygus* Immatures (concluded)

	Instar 1	Instar 2	Instar 3	Instar 4	Instar 5
Antennal Segment 3 Length					
L. borealis	0.22-0.25 (0.24±0.00)	0.29-0.36 (0.34±0.01)	0.45-0.52 (0.48±0.00)	0.61-0.70 (0.66±0.01)	0.76-0.89 (0.82±0.01)
L. elisus D	0.21-0.26 (0.24±0.00)	0.31-0.36 (0.33±0.00)	0.43-0.52 (0.49±0.00)	0.60-0.69 (0.65±0.01)	0.75-0.89 (0.83±0.01)
L. elisus L	0.19-0.22 (0.21±0.00)	0.29-0.32 (0.31±0.00)	0.40-0.47 (0.43±0.00)	0.58-0.63 (0.61±0.01)	0.80-0.88 (0.85±0.01)
L. lineolaris	0.20-0.24 (0.22±0.00)	0.29-0.35 (0.31±0.00)	0.46-0.50 (0.48±0.00)	0.65-0.74 (0.69±0.00)	0.83-0.93 (0.89±0.01)
L. hesperus	0.23-0.26 (0.24±0.00)	0.33-0.36 (0.35±0.00)	0.50-0.56 (0.51±0.01)	0.64-0.76 (0.71±0.01)	0.80-0.99 (0.91±0.02)
L. shulli	—	—	0.49-0.55 (0.53±0.01)	0.64-0.79 (0.72±0.01)	0.90-0.92 (0.92±0.01)
Antennal Segment 4 Length					
L. borealis	0.33-0.38 (0.36±0.00)	0.34-0.45 (0.41±0.01)	0.43-0.52 (0.48±0.00)	0.50-0.57 (0.54±0.00)	0.57-0.65 (0.61±0.00)
L. elisus D	0.33-0.37 (0.35±0.00)	0.39-0.44 (0.41±0.00)	0.46-0.55 (0.51±0.00)	0.56-0.64 (0.60±0.00)	0.63-0.70 (0.67±0.00)
L. elisus L	0.30-0.35 (0.33±0.00)	0.35-0.41 (0.38±0.00)	0.40-0.46 (0.44±0.01)	0.51-0.56 (0.53±0.01)	0.57-0.63 (0.60±0.01)
L. lineolaris	0.39-0.41 (0.41±0.00)	0.43-0.50 (0.48±0.01)	0.53-0.62 (0.58±0.01)	0.64-0.71 (0.69±0.01)	0.71-0.88 (0.79±0.02)
L. hesperus	0.34-0.38 (0.36±0.00)	0.40-0.44 (0.42±0.01)	0.43-0.52 (0.48±0.01)	0.52-0.58 (0.55±0.00)	0.58-0.66 (0.62±0.01)
L. shulli	—	—	0.50-0.56 (0.52±0.01)	0.57-0.65 (0.61±0.01)	0.63-0.67 (0.66±0.01)
Labium Length					
L. borealis	0.67-0.79 (0.73±0.01)	0.80-1.00 (0.91±0.04)	1.22-1.38 (1.29±0.02)	1.56-1.69 (1.63±0.01)	1.93-2.04 (1.99±0.01)
L. elisus D	0.71-0.79 (0.75±0.01)	0.88-0.99 (0.94±0.01)	1.21-1.29 (1.25±0.01)	1.35-1.59 (1.52±0.02)	1.77-1.94 (1.86±0.02)
L. elisus L	0.66-0.71 (0.69±0.01)	0.88-0.93 (0.91±0.01)	1.07-1.16 (1.00±0.15)	1.38-1.45 (1.34±0.02)	1.72-1.79 (1.99±0.04)
L. lineolaris	0.66-0.70 (0.68±0.03)	0.88-0.97 (0.92±0.01)	1.14-1.30 (1.22±0.02)	1.47-1.76 (1.59±0.03)	1.82-2.16 (1.95±0.03)
L. hesperus	0.72-0.77 (0.74±0.01)	0.93-0.98 (0.95±0.01)	1.22-1.43 (1.34±0.03)	1.67-1.83 (1.75±0.02)	2.07-2.21 (2.18±0.02)
L. shulli	—	—	1.27-1.40 (1.33±0.03)	1.69-1.81 (1.63±0.01)	2.13-2.14 (2.29±0.03)
Metatibial Length					
L. borealis	0.48-0.56 (0.53±0.01)	0.55-0.76 (0.68±0.00)	0.89-1.05 (0.96±0.02)	1.30-1.38 (1.35±0.01)	1.67-1.96 (1.83±0.03)
L. elisus D	0.48-0.55 (0.52±0.01)	0.58-0.68 (0.65±0.01)	0.90-1.00 (0.92±0.02)	1.22-1.31 (1.24±0.01)	1.63-1.80 (1.73±0.02)
L. elisus L	0.43-0.52 (0.47±0.01)	0.62-0.68 (0.65±0.01)	0.81-0.96 (0.89±0.01)	1.27-1.40 (1.41±0.01)	1.91-2.10 (1.75±0.01)
L. lineolaris	0.48-0.59 (0.54±0.01)	0.67-0.77 (0.70±0.01)	1.02-1.09 (1.06±0.01)	1.33-1.48 (1.40±0.02)	1.82-2.05 (1.96±0.02)
L. hesperus	0.51-0.56 (0.53±0.00)	0.68-0.76 (0.72±0.01)	1.00-1.06 (1.03±0.01)	1.34-1.52 (1.36±0.09)	2.04-2.25 (2.15±0.02)
L. shulli	—	—	1.08-1.19 (1.14±0.02)	1.55-1.69 (1.75±0.01)	2.23-2.36 (2.14±0.00)

[a] Order of data is range (mean ± standard error); all measurements in mm, number of individuals measured per instar of each species in parentheses as follows: L. borealis, Winnipeg, MB: Instar 1(10), 2(4), 3(10), 4(11), 5(13); L. elisus, Davis, CA: 1-5(10); L. elisus, Lethbridge, AB: 1, 2(6), 3(7), 4(6), 5(5); L. lineolaris, Winnipeg, MB: 1(10), 2(15), 3(20), 4(16), 5(15); L. hesperus, Davis, CA: 1, 2(3), 3-5(7); L. shulli, Lethbridge, AB: 1, 2(0), 3(5), 4(6), 5(2). Both left and right antennal segments and metatibiae measured.

[b] D = L. elisus populations from Davis, CA; L = L. elisus populations from Lethbrige, AB.

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